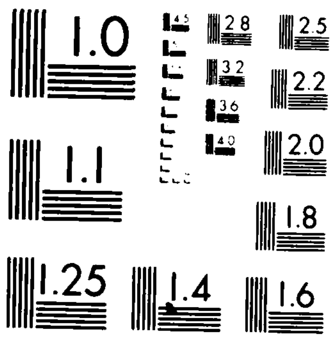
AD-A170 757 THE GULF STREAM DYNAMICS EXPERIMENT INVERTED ECHO 1/3
SOUNDER DATA REPORT FOR..(U) RHODE ISLAND UNIV KINGSTON
GRADUATE SCHOOL OF OCEANOGRAPHY K L TRACEY ET AL.
UNCLASSIFIED APR 86 URI/GSO-TR-86-4 N00014-81-C-0062 F/G 8/10 NL



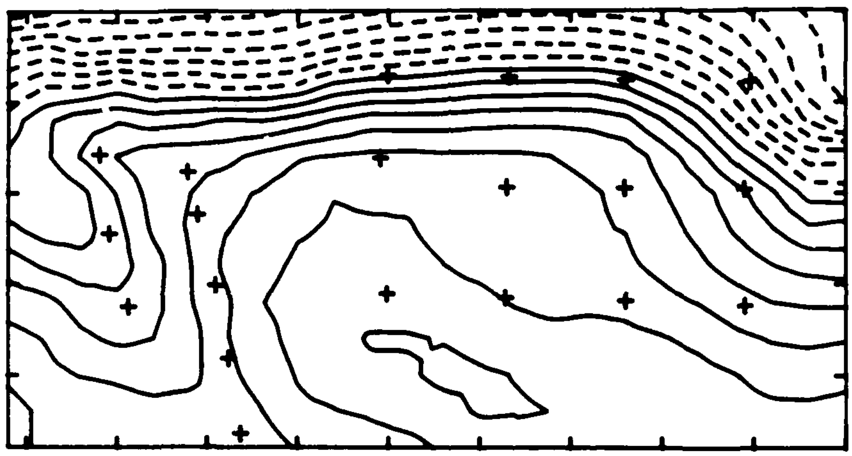
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(3)

THE GULF STREAM DYNAMICS EXPERIMENT:

Inverted Echo Sounder Data Report for the April 1983 to June 1984 Deployment Period

AD-A170 757



DTIC FILE COPY

by

Karen L. Tracey

and

D. Randolph Watts

DTIC
ELECTE
AUG 1 1 1986
S D
D

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

University of Rhode Island
Graduate School of Oceanography
Narragansett, RI 02882

GSO Technical Report Number 86-4

April 1986

86 7

GRADUATE SCHOOL OF OCEANOGRAPHY

UNIVERSITY OF RHODE ISLAND

NARRAGANSETT, RHODE ISLAND

THE GULF STREAM DYNAMICS EXPERIMENT: Inverted Echo Sounder Data Report for the April 1983 to June 1984 Deployment Period

GSO Technical Report No. 86-4

by

Karen L. Tracey
and
D. Randolph Watts

April, 1986

Accesion For
NTIS CRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification
By
Distribution /
Availability Codes
Dist | Avail and / or Special
A-1

This research program has been sponsored by the National Science Foundation under grant number OCE82-01222 and by the Office of Naval Research under contract N00014-81-C-0062.

3

ABSTRACT

The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from September 1983 to May 1985 to study the propagation and growth characteristics of Gulf Stream meanders. Data collected as part of the field experiment included inverted echo sounders, current meter moorings, and AXBT survey flights. This report documents the inverted echo sounder data collected from September 1983 to June 1984, as well as additional measurements made from April to September 1983. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for twenty-two instruments. Bottom pressure and temperature, measured at seven of the sites, are also plotted. Basic statistics are given for all the data records shown. Maps of the thermocline depth field in a 240 km by 460 km region are presented at daily intervals.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1

Experiment Description and Data Processing

1.1 Introduction

This report documents data collected using inverted echo sounders (IES) in the Gulf Stream northeast of Cape Hatteras from April 1983 to June 1984. The measurements were made under the combined support of an NSF project entitled "The Dynamics of Gulf Stream Meanders" and an ONR project entitled "Observations on the Current Structure and Energetics of Gulf Stream Fluctuations Downstream of Cape Hatteras". Other data collected as part of a joint program conducted by the University of Rhode Island (D. R. Watts, P. I.) and the University of North Carolina (J. M. Bane, P. I.) included five current meter moorings with four levels instrumented from 500 m depth to 500 m above the bottom and seven AXBT flights over a larger geographical region. These other data will be documented in separate reports.

The principal objectives of the combined experiments were:

1) determining the propagation and growth characteristics of Gulf Stream meanders and how these vary downstream,

2) determining the detailed structure of the current and temperature fluctuations associated with Gulf Stream meanders in the study area,

3) investigating the baroclinic and barotropic energy transfers between the fluctuations and the mean field of Gulf Stream meanders in an area where meanders are known to be rapidly amplifying,

4) testing for possible generation of deep topographically trapped waves by shallower Gulf Stream meanders, and

5) determining the deep current structure and whether topographical control of Gulf Stream meandering occurs in the study area.

Additionally, these data will be used in cooperation with other ongoing investigations of the Gulf Stream in the same region. Collaboration with P. Cornillon's satellite imagery project (NSF supported) and H. T. Rossby's Rafos float project (ONR and NSF supported) is currently underway to obtain detailed descriptions of the meander characteristics.

To address these objectives, an array of inverted echo sounders and current meter moorings were deployed in the Gulf Stream approximately 200 km downstream of Cape Hatteras. Additionally, bottom pressure and temperature sensors were deployed at five of the sites. The study area, shown in Figure 1, was occupied from April 1983 to May 1985. This report presents the IES data collected between April 1983 and June 1984 and a companion report (Tracey _et al._, 1985) documents the data collected from June 1984 to May 1985.

Initially, from April to September 1983, the array consisted of 13 IESs. It was increased to a maximum of 20 IESs in January 1984, and this large array was maintained until May 1985. The IESs were located on six lines in an approximately rectangular grid 130 km cross-stream by 360 km downstream. The instrument sites are shown in Figure 1 and listed in Table 1. Bottom pressure and temperature sensors were included at two sites along line B and three sites along line C; these sites are indicated in Figure 1 by the solid circles. The instruments were deployed and recovered during four cruises aboard the R/V ENDEAVCR

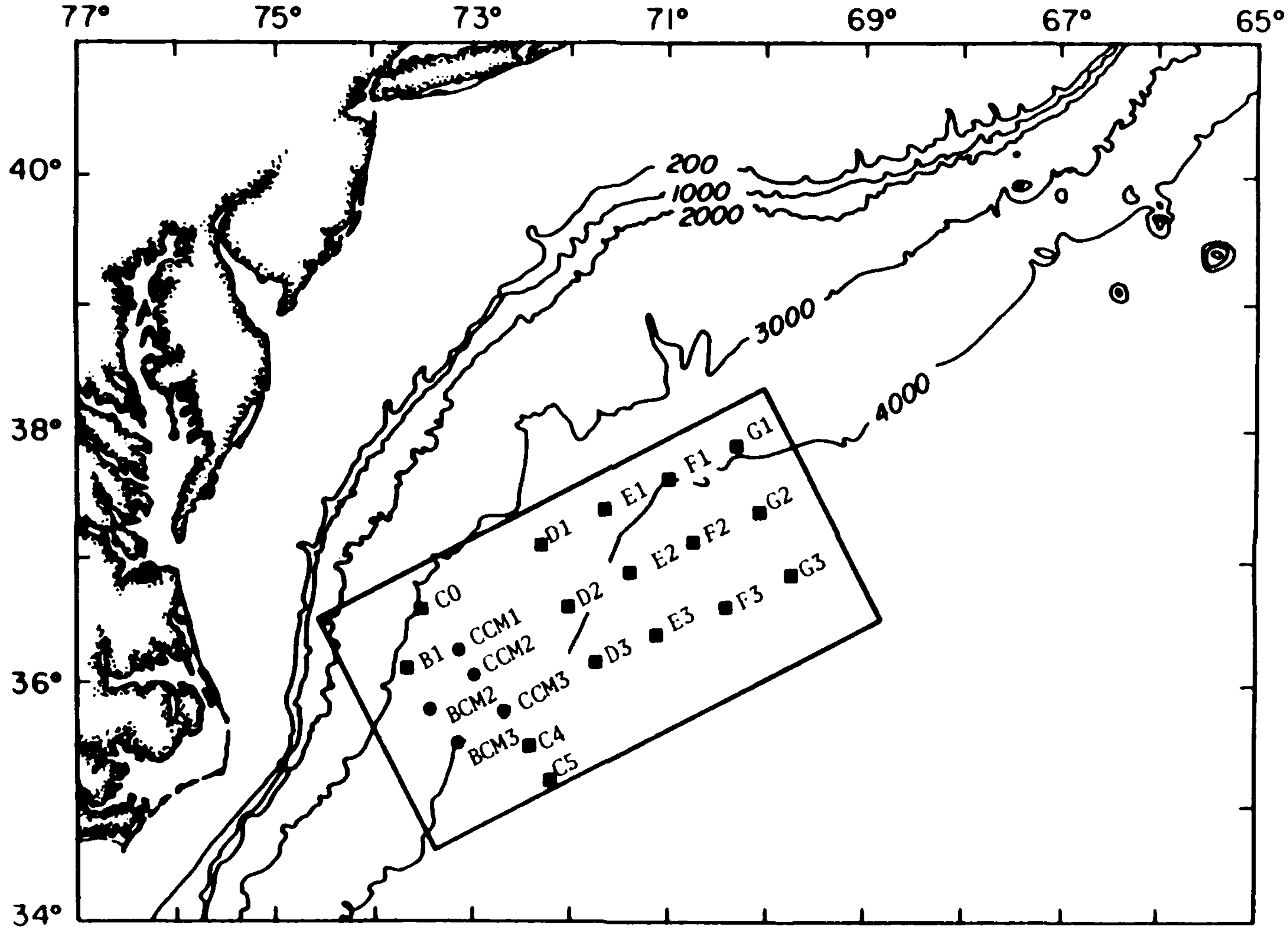


Figure 1. The Gulf Stream Dynamics Experiment Study Area. IES sites (solid squares and circles) along lines B through G were occupied during 1983-1985. IES with bottom pressure gauges and temperature sensors were located at the sites shown by the solid circles. The box outlines the 240 km by 460 km region, shown in Figure 12, which has been mapped by objective analysis. The data for sites C4 and C5 are documented in Tracey et al. (1985). Sites B2 and C1 were the same as BCM2 and CCM1, respectively, before the current meter moorings were deployed there.

Table 1. Instrument Site Locations and Data Returns.

SITE	LATITUDE (N)	LONGITUDE (W)	1983 1984 1985 AMJJASONDJFMAMJJASONDJFMAM
IES84B1	36°08.24	73°41.76	XXXXXXXXXXXXXXX···········
IES84B2	35°48.27	73°23.08	XXXXXX
PIES84B2	35°47.81	73°26.99	XXX
PIES85BCM2	35°48.09	73°25.88	XXXXXXXXXXXXX
PIES85BCM3	35°31.00	73°08.02	XXXXXXXXXXXXX
IES84C0	36°38.06	73°32.90	XXX
PIES84C1	36°17.20	73°11.40	XXX
PIES85CCM1	36°15.23	73°09.89	XXXXXXXXXXXXX····
PIES84CCM2	36°05.02	72°59.94	XXXXXXXX···········
PIES84CCM3	35°48.22	72°42.55	XXXXXX···········
IES85C4	35°30.32	72°26.51	·················
IES85C5	35°11.80	72°10.19	·················
IES84D1	37°07.79	72°19.13	XXXXXXXXXXXXXXX···········
IES84D2	36°44.31	72°08.30	XXXXXXXXXXXXXXX···········
IES84D3	36°08.65	71°44.45	XXXXXXXXXXXXXXX···········
IES84E1	37°23.13	71°38.89	XXXXXXXXXXXXXXX···········
IES84E2	36°52.98	71°21.85	XXXXXXXXXXXXXXX
IES84E3	36°23.11	71°04.64	XXXXXXXXXXXXXXX···········
IES84F1	37°37.42	71°00.02	XXXXXXXXXXXXXXX···········
IES84F2	37°08.11	70°43.02	XXXXXXXXXXXXXXX···········
IES84F3	36°37.96	70°24.76	XXXXXXXXXXXXXXX···········
IES84G1	37°53.46	70°18.99	XXXXXXXXXX···········
IES84G2	37°23.55	70°03.72	XXXXXXXXXX···········
IES84G3	36°52.34	69°44.90	XXXXXXXXXX·

X's denote data shown in this report. Dots denote data documented in Tracey et al., 1985.

(EN106, 22-30 September 1983; EN107, 1-3 November 1983; EN118, 1-18 June 1984; EN124, 11-20 January 1985), one cruise aboard the R/V COLUMBUS ISELIN (CI8304, 16-27 April 1983), and one cruise aboard the R/V OCEANUS (OC144, 9-19 January 1984).

1.2 Site Naming Conventions

The six cross-stream lines are designated from west to east by the letters B through G. The IES sites along each line are numbered consecutively from 1 through 5, with site 1 located at the northwestern end of the line. Along line C, an additional instrument deployed on the northern edge of the line was assigned the number 0. In this report, each instrument site is referred to by both the line letter and site number. The site designator has a prefix of either IES, if it is a standard instrument, or PIES, if it is a combined IES, bottom pressure gauge, and temperature sensor. A two-digit code, either 84 or 85, is used to indicate the year in which the instrument was recovered. For example, IES84D2, the second site from the northern end of line D, was recovered during 1984. Additionally, if a current meter mooring was located at the same site as an IES, the letters CM were included between the line letter and site number (e.g., PIES85CCM1).

1.3 Inverted Echo Sounder Description

A detailed description of the IES is presented in Chaplin and Watts (1984) and will not be repeated here. Briefly, the IES is an instrument which is moored one meter above the ocean floor and which monitors the depth of the main thermocline acoustically. A sample burst of acoustic pulses is transmitted every half hour and the round trip travel times to the surface and back are recorded on a digital cassette

tape within the instrument. For the standard IES, a sample burst typically consists of twenty 10-kHz pings. Additionally, bottom pressure and temperature can be measured and recorded. For instruments with these optional sensors, the travel time burst consists of 24 pings. Bottom pressure and temperature are not sampled in bursts; they are average measurements over the whole sampling interval.

1.4 Data Processing

The raw data is recorded within the IES on Sea Data model 610 recorders. The cassette tape contains the counts associated with travel time, pressure, and temperature measurements as a series of integer words of varying lengths. All processing was done on a PRIME 750 computer, except for the initial dumping of the data from the cassette tapes onto a 9-track magnetic tape. This was done on the Hewlett Packard 2000 series computer maintained by the URI Marine Technicians. The basic processing steps, which include transcription, editing, and conversion into scientific units, are illustrated by the flowchart in Figure 2. The data processing is accomplished by a series of routines specifically developed for the IES (Tracey and Watts, 1986) and these are outlined below.

CARP: Transfers the data from cassettes to 9-track magnetic tape for subsequent processing.

BUNS: Converts the series of integer words of varying lengths into standard length 32-bit integer words.

PUNS: Produces integer listings and histograms of the travel time sample bursts. Provides an initial look at data quality and travel time distributions. Used to determine the first (after launch) and last (before recovery) 'on bottom' samples.

MEMOD: Establishes the time base. Determines either the median or modal value (at the user's option) of the travel time burst as the representative measurement. Converts all travel time, pressure and

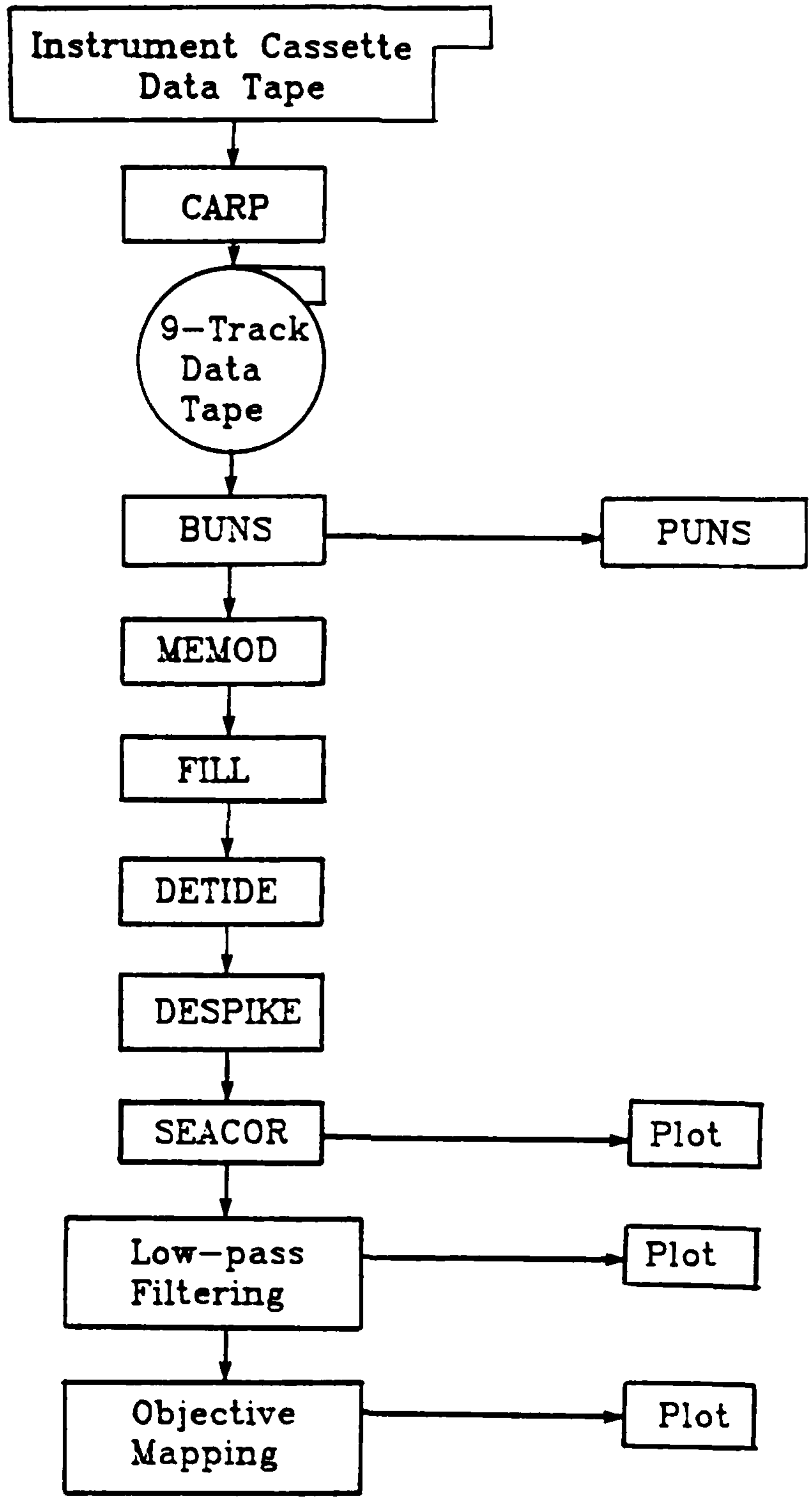


Figure 2. IES Data Processing Flowchart.

temperature counts into scientific units of seconds, decibars, and degrees Celsius, respectively.

FILL: Checks for proper incrementing of the time base. Missing data points are filled by inserting interpolated values.

DETIDE: From user-supplied tidal constituents specific to each site, determines the tidal contribution to the travel times and removes it from the measured values.

DESPIKE: Identifies and replaces travel time spikes with interpolated values.

SEACOR: Removes the effects of seasonal warming and cooling of the surface layers from the travel times. Plots of the half-hourly pressure, temperature and travel time are generated.

LOW-PASS FILTERING: Convolves the travel times, pressures, and temperatures with a 40-hour low-pass Lanczos filter. The smoothed series are subsampled at six-hour intervals and plotted.

OBJECTIVE MAPPING: Produces daily maps of the depth of the 12°C isotherm.

The FESTSA time series analysis package (Brooks, 1976), modified for the PRIME 750, was used to remove the higher frequency (tidal and inertial) motions from those with periods of several days or longer, which are the main focus of this project. The symmetric filter, with a Lanczos taper, was designed with the quarter power point at 0.025 cph and the tidal cycle attenuated by 60 dB. The half-hourly travel time, pressure, and temperature data were low-pass filtered and the smoothed output series (40 HRLP) had sampling intervals of six hours.

1.4.1 Travel Time Calibration

Variations in the travel times have been shown to be proportional to variations in the thermocline depth (Watts and Rossby, 1977; Watts and Wimbush, 1981). Calibration XBTs were taken at each IES site in order to convert the travel times (τ) into thermocline depths (ξ) according to the relation: $\xi = M\tau + B$, where M is -19.0 m/msec and the

intercept B depends on the depth of the instrument. Regressions of τ versus ξ, performed for several instruments, show that a constant scale factor for M is appropriate for all these Gulf Stream sites. The values of B used for each instrument are listed in the tables in Section 2.

For practical purposes the main thermocline depth can be represented by the depth of an individual isotherm. For this work, we have chosen the 12°C isotherm since it situated near the highest temperature gradient of the main thermocline and correlates well with τ (Rossby, 1969; Watts and Johns, 1982). The low-pass filtered travel time records were scaled to the thermocline depths (Z_{12}) and these records are shown in Section 4. The accuracy of the offset parameter B is estimated to be ±25 m for most instruments, judged from the agreement between the several calibration XBTs taken at each site. Relative to this, the 40 HRLP Z_{12} values are resolved to ±2 m.

1.4.2 Thermocline Depth Mapping

Objective maps of the thermocline (Z_{12}) field in the array region have been produced at daily intervals from these records. The boxed region in Figure 1, oriented 064°T, is the region which has been mapped. The objective mapping techniques were developed by E. Carter (1983) and special adaptations for their application to the Gulf Stream frontal zone are discussed in Watts and Tracey (1985). Two results presented in this latter work are of particular importance to the objective mapping performed here: 1) If the mean field is removed, the perturbations have essentially isotropic correlation fields. 2) They show the space-time correlation functions used for the objective analysis.

The objective analysis is performed on the "perturbation fields", which are obtained by removing the mean field from the input dataset and normalizing the standard deviation. To represent the mean field, $\overline{Z_{12}}(x,y)$, a third order polynomial was fitted to the mean values observed during the April 1983 to June 1984 deployment period. The function form of the polynomial was:

$$\overline{Z_{12}}(x,y) = B_0 + B_1x + B_2y + B_{11}x^2 + B_{12}xy + B_{22}y^2 + B_{111}x^3 + B_{112}x^2y + B_{122}xy^2 + B_{222}y^3$$

where (x,y) is the position in kilometers from the origin at 36°00'N, 73°30'W, B_0 is 5.767184E+02, B_1 is 5.752054E-02, B_2 is -3.939068E+00, B_{11} is -1.113917E-03, B_{12} is 1.970595E-03, B_{22} is -9.249152E-03, B_{111} is 2.640075E-06, B_{112} is -2.609863E-06, B_{122} is 1.240944E-05, and B_{222} is 4.856306E-05. The standard deviation field, $\sigma(x,y)$, was defined as a function of the mean field depth, from a Gaussian form representative of all IES records:

$$\sigma(x,y) = A + B \exp - \left[\frac{Z_{12}(x,y) - Z_0}{C}\right]^2$$

where A is 50 m, B is (200 m - A), C is 200 m, Z_0 is 470 m, and $\overline{Z_{12}}(x,y)$ is the mean value at that (x,y) location. Figure 10 shows both the mean and standard deviation fields in plan view.

For each output grid point, the objective mapping technique selects, from all the input data within a specified maximum time lag (T) and radial distance (R), the number of points (N) which have the highest correlations. The output fields in Figures 11 and 12 result from specifying N = 9, T = ±4 days, and R = 120 km, and using the idealized correlation function (Watts and Tracey, 1985) with an assumed noise level E = 0.05.

The output of the objective mapping is the perturbation field (Figure 12) on a full grid of points, with 20 km grid spacing, within the mapped region. The thermocline depth maps (also shown in Figure 12) are obtained by renormalizing the perturbation field by the standard deviation and restoring the mean. In this report, three different sizes of regions are mapped, depending on the locations of the instrument sites. These are: 1) For the period from April to September 1983, the region mapped is 200 km cross-stream by 400 km downstream. 2) From September 1983 to January 1984, it is 200 km by 460 km. 3) From January to June 1984, it is 240 km by 460 km. The accuracy of these output fields can be obtained from the estimated error fields, which are shown in Figure 11. A detailed discussion of the accuracy is given in Watts and Tracey (1986).

1.4.3 Temperature

Temperatures were measured using Sea Data DC-37B electronics and a Yellow Springs International Corporation thermistor (model 44032), in order to correct the pressure values for the temperature sensitivity of the transducer. The thermistor is inside the instrument, on the pressure tranducer, rather than in the water. However, once the temperature probe has reached equilibrium with the surrounding waters, it also provides accurate measurements of the bottom temperature fluctuations (effectively low-pass filtered with a 4-hour e-folding equilibrium time). The first 24 half-hourly points were dropped prior to low-pass filtering, since the temperatures took 12 hours to reach equilibrium within 0.001°C. The accuracy of the temperature measurements is about 0.1°C, and the resolution is 0.0002°C.

1.4.4 Bottom Pressure

Digiquartz pressure sensors (models 75K-002 and 76KB-032) manufactured by Paroscientific, Inc. were used to measure bottom pressure. They were powered and controlled by Sea Data Corporation model XP35 electronics cards, which were installed in the IESs. All pressure measurements were corrected for the temperature sensitivity of the transducer (Watts and Kontoyiannis, 1986a) using calibration coefficients purchased from the manufacturer. The half-hourly measured bottom pressures (Figures 4.1-4.4) are dominated by the tides; however, for some of the instruments, the pressures also drift [O(0.4 dbar)] monotonically with time. Processing of the pressure measurements includes removing the long-term drift and the tides as follows.

Tidal response analysis (Munk and Cartwright, 1966) was used to determine the tidal constituents for each instrument. The calculated tides were then removed from the pressure records. The amplitudes, H (dbar), and phases, G° (Greenwich epoch), of the constituents are given in the tables in Section 2.

In order to estimate and remove the long-term drift from the measurements, we least-squares fitted a logarithmic function to our data (Watts and Kontoyiannis, 1986a and b). The functional form was:

$$\mathrm{DRIFT} = P_1 \ln(t - t_0) + P_2$$

where t is the time, t_0 is the time of initial pressurization, and P_1 and P_2 are free parameters. For all instruments, t_0 was chosen to be a specific time after launch, one half hour before the first bottom sample. The parameters P_1 and P_2 were determined for each instrument using the non-linear regression subroutine P3R of BMDP-79, a package of

computer programs developed at the Health Science Computing Facility, UCLA (Dixon and Brown, 1979). These coefficients are listed in Section 2 for each record which had a measureable drift.

The half-hourly pressures are resolved to 0.001 dbar, and the mean pressure is accurate to within 1.5 dbar. We estimate that the residual (drift and tide removed) bottom pressure records have an accuracy (relative to their mean pressures) of at least 0.05 dbar (Watts and Kontoyannis, 1986b). The residual bottom pressure records were low-pass filtered as mentioned above.

1.4.5 Time Base

The date and time were assigned to each sampling period. The tables in Section 2 report the hour, minutes, and seconds associated with the first and last sampling period as a six-digit number. All times are given as Greenwich Mean Time (GMT). For processing convenience, the times were converted into yearhours. Table 2 lists the yearhour which corresponds to 0000 GMT of each day for non-leap years. (For leap years, the yearhours can be determined by adding 24 to each day after February 28.) There are a total of 8760 hours in a standard year and 8784 hours in a leap year. The yearhours given in this report are referenced to 0000 GMT on either January 1, 1984 or January 1, 1985, depending on the year in which the IES was recovered; the two-digit number of the site name indicates which date is the reference. Positive yearhours correspond to sampling periods which occur during the same calendar year as the reference date; negative yearhours correspond to those which occur in the calendar year prior to the reference.

Table 2. Yearhour Calendar for Non-Leap Years. Only the yearhour corresponding to 0000 GMT is listed for each day.

JAN			FEB			MAR			APR			MAY			JUNE		
DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)
1	1	0	1	32	744	1	60	1416	1	91	2160	1	121	2880	1	152	3624
2	2	24	2	33	768	2	61	1440	2	92	2184	2	122	2904	2	153	3648
3	3	48	3	34	792	3	62	1464	3	93	2208	3	123	2928	3	154	3672
4	4	72	4	35	816	4	63	1488	4	94	2232	4	124	2952	4	155	3696
5	5	96	5	36	840	5	64	1512	5	95	2256	5	125	2976	5	156	3720
6	6	120	6	37	864	6	65	1536	6	96	2280	6	126	3000	6	157	3744
7	7	144	7	38	888	7	66	1560	7	97	2304	7	127	3024	7	158	3768
8	8	168	8	39	912	8	67	1584	8	98	2328	8	128	3048	8	159	3792
9	9	192	9	40	936	9	68	1608	9	99	2352	9	129	3072	9	160	3816
10	10	216	10	41	960	10	69	1632	10	100	2376	10	130	3096	10	161	3840
11	11	240	11	42	984	11	70	1656	11	101	2400	11	131	3120	11	162	3864
12	12	264	12	43	1008	12	71	1680	12	102	2424	12	132	3144	12	163	3888
13	13	288	13	44	1032	13	72	1704	13	103	2448	13	133	3168	13	164	3912
14	14	312	14	45	1056	14	73	1728	14	104	2472	14	134	3192	14	165	3936
15	15	336	15	46	1080	15	74	1752	15	105	2496	15	135	3216	15	166	3960
16	16	360	16	47	1104	16	75	1776	16	106	2520	16	136	3240	16	167	3984
17	17	384	17	48	1128	17	76	1800	17	107	2544	17	137	3264	17	168	4008
18	18	408	18	49	1152	18	77	1824	18	108	2568	18	138	3288	18	169	4032
19	19	432	19	50	1176	19	78	1848	19	109	2592	19	139	3312	19	170	4056
20	20	456	20	51	1200	20	79	1872	20	110	2616	20	140	3336	20	171	4080
21	21	480	21	52	1224	21	80	1896	21	111	2640	21	141	3360	21	172	4104
22	22	504	22	53	1248	22	81	1920	22	112	2664	22	142	3384	22	173	4128
23	23	528	23	54	1272	23	82	1944	23	113	2688	23	143	3408	23	174	4152
24	24	552	24	55	1296	24	83	1968	24	114	2712	24	144	3432	24	175	4176
25	25	576	25	56	1320	25	84	1992	25	115	2736	25	145	3456	25	176	4200
26	26	600	26	57	1344	26	85	2016	26	116	2760	26	146	3480	26	177	4224
27	27	624	27	58	1368	27	86	2040	27	117	2784	27	147	3504	27	178	4248
28	28	648	28	59	1392	28	87	2064	28	118	2808	28	148	3528	28	179	4272
29	29	672				29	88	2088	29	119	2832	29	149	3552	29	180	4296
30	30	696				30	89	2112	30	120	2856	30	150	3576	30	181	4320
31	31	720				31	90	2136				31	151	3600			

JULY			AUG			SEPT			OCT			NOV			DEC		
DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)	DATE	YEAR DAY	HOUR (0000Z)
1	182	4344	1	213	5088	1	244	5832	1	274	6552	1	305	7296	1	335	8016
2	183	4368	2	214	5112	2	245	5856	2	275	6576	2	306	7320	2	336	8040
3	184	4392	3	215	5136	3	246	5880	3	276	6600	3	307	7344	3	337	8064
4	185	4416	4	216	5160	4	247	5904	4	277	6624	4	308	7368	4	338	8088
5	186	4440	5	217	5184	5	248	5928	5	278	6648	5	309	7392	5	339	8112
6	187	4464	6	218	5208	6	249	5952	6	279	6672	6	310	7416	6	340	8136
7	188	4488	7	219	5232	7	250	5976	7	280	6696	7	311	7440	7	341	8160
8	189	4512	8	220	5256	8	251	6000	8	281	6720	8	312	7464	8	342	8184
9	190	4536	9	221	5280	9	252	6024	9	282	6744	9	313	7488	9	343	8208
10	191	4560	10	222	5304	10	253	6048	10	283	6768	10	314	7512	10	344	8232
11	192	4584	11	223	5328	11	254	6072	11	284	6792	11	315	7536	11	345	8256
12	193	4608	12	224	5352	12	255	6096	12	285	6816	12	316	7560	12	346	8280
13	194	4632	13	225	5376	13	256	6120	13	286	6840	13	317	7584	13	347	8304
14	195	4656	14	226	5400	14	257	6144	14	287	6864	14	318	7608	14	348	8328
15	196	4680	15	227	5424	15	258	6168	15	288	6888	15	319	7632	15	349	8352
16	197	4704	16	228	5448	16	259	6192	16	289	6912	16	320	7656	16	350	8376
17	198	4728	17	229	5472	17	260	6216	17	290	6936	17	321	7680	17	351	8400
18	199	4752	18	230	5496	18	261	6240	18	291	6960	18	322	7704	18	352	8424
19	200	4776	19	231	5520	19	262	6264	19	292	6984	19	323	7728	19	353	8448
20	201	4800	20	232	5544	20	263	6288	20	293	7008	20	324	7752	20	354	8472
21	202	4824	21	233	5568	21	264	6312	21	294	7032	21	325	7776	21	355	8496
22	203	4848	22	234	5592	22	265	6336	22	295	7056	22	326	7800	22	356	8520
23	204	4872	23	235	5616	23	266	6360	23	296	7080	23	327	7824	23	357	8544
24	205	4896	24	236	5640	24	267	6384	24	297	7104	24	328	7848	24	358	8568
25	206	4920	25	237	5664	25	268	6408	25	298	7128	25	329	7872	25	359	8592
26	207	4944	26	238	5688	26	269	6432	26	299	7152	26	330	7896	26	360	8616
27	208	4968	27	239	5712	27	270	6456	27	300	7176	27	331	7920	27	361	8640
28	209	4992	28	240	5736	28	271	6480	28	301	7200	28	332	7944	28	362	8664
29	210	5016	29	241	5760	29	272	6504	29	302	7224	29	333	7968	29	363	8688
30	211	5040	30	242	5784	30	273	6528	30	303	7248	30	334	7992	30	364	8712
31	212	5064	31	243	5808				31	304	7272				31	364	8736

1.5 Data Recovery

Table 1 summarizes the data returns from each of the inverted echo sounders. All 22 instruments documented in this report were recovered, giving an instrument recovery rate of 100%. The travel time detectors on these instruments performed successfully, resulting in a 100% data return rate. The electronics card controlling one pressure sensor malfunctioned during its deployment, and the data record from another pressure sensor had large jumps (both positive and negative), indicating that its sensor malfunctioned. Thus the recovery rate for the bottom pressure data was only 72%. Seven complete records were obtained for temperature sensors; thus the return rate was 100% for these data.

SECTION 2

Individual Site and Record Information Tables

The following tables provide information about the location, dates, and basic statistics of the data records, which are plotted in Sections 3 and 4. Each table documents a single instrument site.

General site information, such as position, bottom depth, and launch and recovery times, are given first. Subsequently, details about the travel time, bottom pressure and temperature records plotted in Sections 3 and 4 are tabulated. For each plot, the times associated with the first and last data point are supplied. All yearhours are referenced to 0000 GMT on either January 1, 1984 or January 1, 1985. The two-digit number (84 or 85) of the site name indicates which date is the reference. Measurements made during the calendar year prior to the reference date are given as negative yearhours.

The first order statistics (minimum, maximum, mean, and standard deviation) were calculated for the half-hourly and the 40 HRLP records for each variable. These are also presented in the following tables.

IES84B1

Serial Number: 012
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°08.24 N, 73°41.76 W   Depth: 3160 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 25, 1983	1804	CI8304
RECOVERY:	Jun 7, 1984	0904	EN118

TRAVEL TIME RECORDS
(Fig. 3.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 25, 1983	185555	-6005.0681
LAST DATA POINT:	Jun 7, 1984	085555	3800.9319

Number of Points: 19613
Sampling Interval: 0.50 hrs

Minimum τ = 4.17667 s   Mean = 4.19142 s
Maximum τ = 4.20758 s   Standard Deviation = 0.00833 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000 \mathrm{ms}^{-1})(\tau_d) + B$
where $B = 80023.55$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 27, 1983	060000	-5970.00
LAST DATA POINT:	Jun 6, 1984	000000	3768.00

Number of Points: 1624
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 109.05 m   Mean = 386.01 m
Maximum Z_{12} = 650.09 m   Standard Deviation = 160.33 m

IES84B2

Serial Number: 014
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 35°48.27 N, 73°23.08 W — Depth: 3625 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 25, 1983	2130	CI8304
RECOVERY:	Sep 24, 1983	0759	EN106

TRAVEL TIME RECORDS
(Fig. 3.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 25, 1983	222210	-6001.6306
LAST DATA POINT:	Sep 24, 1983	075210	-2368.1306

Number of Points: 7268
Sampling Interval: 0.50 hrs

Minimum τ = 4.82774 s
Maximum τ = 4.84007 s
Mean = 4.83279 s
Standard Deviation = 0.00183 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$
where $B = 92468.44$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 27, 1983	060000	-5970.00
LAST DATA POINT:	Sep 23, 1983	000000	-2400.00

Number of Points: 596
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 525.63 m
Maximum Z_{12} = 729.71 m
Mean = 644.95 m
Standard Deviation = 49.92 m

PIES84B2

Serial Number: 055
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 8181

Position: 35°47.81 N — Depth: 3570 m
73°26.99 W

	DATE	GMT	CRUISE
LAUNCH:	Sep 24, 1983	1023	EN106
RECOVERY:	Jan 11, 1984	2204	OC144

TRAVEL TIME RECORDS
(Fig. 3.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 24, 1983	113146	-2364.4706
LAST DATA POINT:	Nov 18, 1983	053146	-1050.4706

Number of Points: 2629
Sampling Interval: 0.50 hrs

Minimum τ = 0.33422 s — Mean = 0.33832 s
Maximum τ = 0.34383 s — Standard Deviation = 0.00173 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 7023.61 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 25, 1983	180000	-2334.00
LAST DATA POINT:	Nov 17, 1983	000000	-1080.00

Number of Points: 210
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 520.56 m — Mean = 595.11 m
Maximum Z_{12} = 652.38 m — Standard Deviation = 30.38 m

PIES84B2 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 24, 1983	112952	-2364.5025
LAST DATA POINT:	Nov 18, 1983	052952	-1050.5025

Number of points: 2629
Sampling Interval: 0.50 hrs

Minimum = 3623.79 dbar
Maximum = 3625.18 dbar

Mean = 3624.43 dbar
Standard deviation = 0.33 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.1)

$$P_{residual} = P_{measured} - \text{MEAN} - \text{DRIFT} - \text{TIDE}$$

$$\text{DRIFT} = P_1 \ln(t - t_0) + P_2$$

where t = Time of sample in yearhours
t_0 = -2365.0025 hrs
P_1 = -0.037278 dbar
P_2 = 0.231444 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42427	.10616	.08304	.01971	.09128	.06666	.02991	.01460
G°:	353.50	335.77	20.90	21.65	183.08	186.63	182.51	194.59

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 24, 1983	232952	-2352.5025
LAST DATA POINT:	Nov 18, 1983	052952	-1050.5025

Number of points: 2605
Sampling Interval: 0.50 hrs

Minimum = -0.1155 dbar
Maximum = 0.1216 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0421 dbar

PIES84B2 (continued)

40HRLP PRESSURE RECORDS
(Fig. 8.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 26, 1983	060000	-2322.0000
LAST DATA POINT:	Nov 17, 1983	000000	-1080.0000

Number of points: 208
Sampling Interval: 6.00 hrs

Minimum = -0.0801 dbar
Maximum = 0.0880 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0379 dbar

TEMPERATURE RECORDS
(Fig. 6.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 24, 1983	232952	-2352.5025
LAST DATA POINT:	Nov 18, 1983	052952	-1050.5025

Number of points: 2605
Sampling Interval: 0.50 hrs

Minimum = 2.173 °C
Maximum = 2.272 °C
Mean = 2.219 °C
Standard deviation = 0.026 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 26, 1983	060000	-2322.0000
LAST DATA POINT:	Nov 17, 1983	000000	-1080.0000

Number of points: 208
Sampling Interval: 6.00 hrs

Minimum = 2.173 °C
Maximum = 2.264 °C
Mean = 2.220 °C
Standard deviation = 0.025 °C

PIES85BCM2

Serial Number: 055
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 8181

Position: 35°48.09 N
73°25.88 W

Depth: 3560 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 16, 1984	2344	OC144
RECOVERY:	Jan 17, 1985	0104	EN124

TRAVEL TIME RECORDS
(Fig. 3.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	003122	-8399.4772
LAST DATA POINT:	Jan 17, 1985	013122	384.5228

Number of Points: 17569
Sampling Interval: 0.50 hrs

Minimum τ = 0.35622 s
Maximum τ = 0.37611 s

Mean = 0.36169 s
Standard Deviation = 0.00258 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,\mathrm{ms}^{-1})(\tau_d) + B$
where B = 7543.76 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1984	060000	-8370.00
LAST DATA POINT:	Jan 15, 1985	180000	354.00

Number of Points: 1455
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 418.56 m
Maximum Z_{12} = 754.77 m

Mean = 671.53 m
Standard Deviation = 47.53 m

PIES85BCM2 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	005927	-8399.0092
LAST DATA POINT:	Jan 17, 1985	002927	384.4908

Number of points: 17568
Sampling Interval: 0.50 hrs

Minimum = 3645.84 dbar
Maximum = 3647.71 dbar
Mean = 3646.57 dbar
Standard deviation = 0.34 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.2)

$$P_{residual} = P_{measured} - \text{MEAN} - \text{DRIFT} - \text{TIDE}$$

DRIFT = $P_1 \ln(t - t_0) + P_2$
where t = Time of sample in yearhours
t_0 = -8399.5092 hrs
P_1 = -0.048840 dbar
P_2 = 0.394873 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43233	.10587	.08715	.02063	.09064	.06984	.02990	.01485
G°:	352.84	334.00	19.68	20.29	181.05	186.12	181.76	184.73

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	125927	-8387.0092
LAST DATA POINT:	Jan 16, 1985	235927	383.9908

Number of points: 17543
Sampling Interval: 0.50 hrs

Minimum = -0.1984 dbar
Maximum = 0.1672 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0450 dbar

PIES85BCM2 (continued)

40HRLP PRESSURE RECORDS
(Fig. 8.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 15, 1985	180000	354.0000

Number of points: 1452
Sampling Interval: 6.00 hrs

Minimum = -0.1835 dbar
Maximum = 0.1275 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0444 dbar

TEMPERATURE RECORDS
(Fig. 6.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	125927	-8387.0092
LAST DATA POINT:	Jan 16, 1985	235927	383.9908

Number of points: 17543
Sampling Interval: 0.50 hrs

Minimum = 2.166 °C
Maximum = 2.435 °C
Mean = 2.234 °C
Standard deviation = 0.052 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 15, 1985	180000	354.0000

Number of points: 1452
Sampling Interval: 6.00 hrs

Minimum = 2.168 °C
Maximum = 2.433 °C
Mean = 2.234 °C
Standard deviation = 0.051 °C

PIES85BCM3

Serial Number: 034
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Number: 18426

Position: 35°31.00 N   Depth: 3930 m
73°08.02 W

	DATE	GMT	CRUISE
LAUNCH:	Jan 15, 1984	0352	OC144
RECOVERY:	Jan 3, 1985	0419	Timed Release
	(Recovered in Bermuda on Feb 8, 1985)		

TRAVEL TIME RECORDS
(Fig. 3.5)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	045125	-8443.1431
LAST DATA POINT:	Jan 3, 1985	035125	51.8569

Number of Points: 16991
Sampling Interval: 0.50 hrs

Minimum τ = 0.03772 s   Mean = 0.04442 s
Maximum τ = 0.06289 s   Standard Deviation = 0.00278 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$
where $B = 1609.34$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 16, 1984	120000	-8412.00
LAST DATA POINT:	Jan 1, 1985	180000	18.00

Number of Points: 1406
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 439.15 m   Mean = 765.44 m
Maximum Z_{12} = 870.84 m   Standard Deviation = 51.70 m

PIES85BCM3 (continued)

No **PRESSURES** are shown due to the poor quality of the data.

TEMPERATURE RECORDS
(Fig. 6.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	164930	-8431.1750
LAST DATA POINT:	Jan 3, 1985	034930	51.8250

Number of points: 16967
Sampling Interval: 0.50 hrs

Minimum = 2.441 °C
Maximum = 2.558 °C
Mean = 2.468 °C
Standard deviation = 0.013 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	000000	-8400.0000
LAST DATA POINT:	Jan 1, 1985	180000	18.0000

Number of points: 1404
Sampling Interval: 6.00 hrs

Minimum = 2.441 °C
Maximum = 2.525 °C
Mean = 2.468 °C
Standard deviation = 0.013 °C

IES84CO

Serial Number: 030
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°38.06 N, 73°32.90 W — Depth: 2950 m

	DATE	GMT	CRUISE
LAUNCH:	Nov 1, 1983	1546	EN107
RECOVERY:	Jan 11, 1984	0247	OC144

TRAVEL TIME RECORDS
(Fig. 3.6)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 1, 1983	163143	-1447.4714
LAST DATA POINT:	Jan 11 1984	024643	242.7786

Number of Points: 6762
Sampling Interval: 0.25 hrs

Minimum τ = 3.94126 s
Maximum τ = 3.96331 s
Mean = 3.95692 s
Standard Deviation = 0.00492 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$
where B = 75379.20 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	000000	-1416.00
LAST DATA POINT:	Jan 9, 1984	180000	210.00

Number of Points: 272
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 98.86 m
Maximum Z_{12} = 473.50 m
Mean = 198.12 m
Standard Deviation = 94.57 m

PIES84C1

Serial Number: 056
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17848

Position: 36°17.20 N — Depth: 3450 m
73°11.40 W

	DATE	GMT	CRUISE
LAUNCH:	Nov 1, 1983	1903	EN107
RECOVERY:	Jan 11, 1984	1459	OC144

TRAVEL TIME RECORDS
(Fig. 3.7)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 1, 1983	200601	-1443.8997
LAST DATA POINT:	Jan 11, 1984	143601	254.6003

Number of Points: 3398
Sampling Interval: 0.50 hrs

Minimum τ = 0.19067 s — Mean = 0.20454 s
Maximum τ = 0.21702 s — Standard Deviation = 0.00662 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$
where B = 4232.31 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	060000	-1410.00
LAST DATA POINT:	Jan 10, 1984	060000	222.00

Number of Points: 273
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 149.88 m — Mean = 348.05 m
Maximum Z_{12} = 576.75 m — Standard Deviation = 126.21 m

PIES84C1 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 1, 1983	200406	-1443.9317
LAST DATA POINT:	Jan 11, 1984	143406	254.5683

Number of points: 3398
Sampling Interval: 0.50 hrs

Minimum = 3513.52 dbar
Maximum = 3515.04 dbar
Mean = 3514.20 dbar
Standard deviation = 0.33 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.3)

$$P_{residual} = P_{measured} - \text{MEAN} - \text{TIDE}$$

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42659	.09910	.08669	.02037	.09116	.06876	.03045	.01264
G°:	353.61	335.45	21.83	23.82	181.16	188.76	182.42	185.16

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 2, 1983	080406	-1431.9317
LAST DATA POINT:	Jan 11, 1984	143406	254.5683

Number of points: 3374
Sampling Interval: 0.50 hrs

Minimum = -0.1434 dbar
Maximum = 0.1374 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0405 dbar

40HRLP PRESSURE RECORDS
(Fig. 8.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jan 10, 1984	060000	222.0000

Number of points: 271
Sampling Interval: 6.00 hrs

Minimum = -0.0828 dbar
Maximum = 0.0818 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0341 dbar

PIES84C1 (continued)

TEMPERATURE RECORDS
(Fig. 6.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 2, 1983	080406	-1431.9317
LAST DATA POINT:	Jan 11, 1984	143406	254.5683

Number of points: 3374
Sampling Interval: 0.50 hrs

Minimum = 2.220 °C
Maximum = 2.349 °C
Mean = 2.258 °C
Standard deviation = 0.028 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jan 10, 1984	060000	222.0000

Number of points: 271
Sampling Interval: 6.00 hrs

Minimum = 2.221 °C
Maximum = 2.348 °C
Mean = 2.258 °C
Standard deviation = 0.028 °C

PIES85CCM1

Serial Number: 056
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Number: 17848

Position: 36°15.23 N   Depth: 3475 m
73°09.89 W

	DATE	GMT	CRUISE
LAUNCH:	Jan 17, 1984	0505	OC144
RECOVERY:	Jan 14, 1985	0029	EN124

TRAVEL TIME RECORDS
(Fig. 3.8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	054530	-8394.2417
LAST DATA POINT:	Jan 14, 1985	001530	312.2583

Number of Points: 17414
Sampling Interval: 0.50 hrs

Minimum τ = 0.21649 s   Mean = 0.22576 s
Maximum τ = 0.24212 s   Standard Deviation = 0.00409 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 \text{ms}^{-1})(\tau_d) + B$
where B = 4912.21 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1984	120000	-8364.00
LAST DATA POINT:	Jan 12, 1985	180000	282.00

Number of Points: 1442
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 344.32 m   Mean = 623.01 m
Maximum Z_{12} = 745.13 m   Standard Deviation = 76.39 m

PIES85CCM1 (continued)

No **PRESSURES** were measured due to the failure of the electronics card.

TEMPERATURE RECORDS
(Fig. 6.5)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	174335	-8382.2736
LAST DATA POINT:	Jan 14, 1985	001335	312.2264

Number of points: 17390
Sampling Interval: 0.50 hrs

Minimum = 2.160 °C
Maximum = 2.488 °C
Mean = 2.251 °C
Standard deviation = 0.070 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 12, 1985	120000	276.0000

Number of points: 1439
Sampling Interval: 6.00 hrs

Minimum = 2.162 °C
Maximum = 2.468 °C
Mean = 2.251 °C
Standard deviation = 0.070 °C

PIES84CCM2

Serial Number: 057
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17849

Position: 36°05.02 N, 72°59.94 W   Depth: 3660 m

	DATE	GMT	CRUISE
LAUNCH:	Nov 1, 1983	2158	EN107
RECOVERY:	Jun 7, 1984	1514	EN118

TRAVEL TIME RECORDS
(Fig. 3.9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 1, 1983	230935	-1440.8403
LAST DATA POINT:	Jun 7, 1984	150935	3807.1597

Number of Points: 10497
Sampling Interval: 0.50 hrs

Minimum τ = 0.06443 s   Mean = 0.07174 s
Maximum τ = 0.08584 s   Standard Deviation = 0.00474 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 \mathrm{ms}^{-1})(\tau_d) + B$
where B = 2031.45 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	060000	-1410.00
LAST DATA POINT:	Jun 6, 1984	060000	3774.00

Number of Points: 865
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 436.17 m   Mean = 669.07 m
Maximum Z_{12} = 787.61 m   Standard Deviation = 88.74 m

PIES84CCM2 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 1, 1983	230740	-1440.8722
LAST DATA POINT:	Jun 7, 1984	150740	3807.1278

Number of points: 10497
Sampling Interval: 0.50 hrs

Minimum = 3732.74 dbar
Maximum = 3734.59 dbar
Mean = 3733.57 dbar
Standard deviation = 0.35 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.4)

$$P_{residual} = P_{measured} - \text{MEAN} - \text{DRIFT} - \text{TIDE}$$

$$\text{DRIFT} = P_1 \ln(t - t_0) + P_2$$

where t = Time of sample in yearhours
t_0 = -1441.3722 hrs
P_1 = -0.112501 dbar
P_2 = 0.852820 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43285	.10601	.08994	.02138	.09200	.06898	.03032	.01438
G°:	352.23	332.50	19.29	19.72	180.70	185.78	181.46	183.90

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 2, 1983	110740	-1428.8722
LAST DATA POINT:	Jun 7, 1984	150740	3807.1278

Number of points: 10473
Sampling Interval: 0.50 hrs

Minimum = -0.2164 dbar
Maximum = 0.1407 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0542 dbar

PIES84CCM2 (continued)

40HRLP PRESSURE RECORDS
(Fig. 8.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jun 6, 1984	060000	3774.0000

Number of points: 863
Sampling Interval: 6.00 hrs

Minimum = -0.1920 dbar
Maximum = 0.1057 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0503 dbar

TEMPERATURE RECORDS
(Fig. 6.6)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 2, 1983	110740	-1428.8722
LAST DATA POINT:	Jun 7, 1984	150740	3807.1278

Number of points: 10473
Sampling Interval: 0.50 hrs

Minimum = 2.244 °C
Maximum = 2.483 °C

Mean = 2.319 °C
Standard deviation = 0.058 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jun 6, 1984	060000	3774.0000

Number of points: 863
Sampling Interval: 6.00 hrs

Minimum = 2.246 °C
Maximum = 2.476 °C

Mean = 2.319 °C
Standard deviation = 0.057 °C

PIES84CCM3

Serial Number: 036
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17911

Position: 35°48.22 N, 72°42.55 W   Depth: 3900 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 15, 1984	0822	OC144
RECOVERY:	Jun 7, 1984	2109	EN118

TRAVEL TIME RECORDS
(Fig. 3.10)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	093148	345.5300
LAST DATA POINT:	Jun 7, 1984	210148	3813.0300

Number of Points: 6936
Sampling Interval: 0.50 hrs

Minimum τ = 0.39461 s
Maximum τ = 0.41225 s
Mean = 0.40035 s
Standard Deviation = 0.00260 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,\mathrm{ms}^{-1})(\tau_d) + B$
where B = 8370.70 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 16, 1984	180000	378.00
LAST DATA POINT:	Jun 6, 1984	120000	3780.00

Number of Points: 568
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 568.73 m
Maximum Z_{12} = 851.59 m
Mean = 746.25 m
Standard Deviation = 48.67 m

PIES84CCM3 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.5)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	092953	345.4981
LAST DATA POINT:	Jun 7, 1984	205953	3812.9981

Number of points: 6936
Sampling Interval: 0.50 hrs

Minimum = 3990.19 dbar
Maximum = 3991.80 dbar
Mean = 3990.94 dbar
Standard deviation = 0.34 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.5)

$$P_{residual} = P_{measured} - \text{MEAN} - \text{TIDE}$$

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43048	.10519	.09131	.02181	.09100	.06813	.02987	.01475
G°:	352.05	332.17	19.27	19.72	181.50	185.05	181.98	184.07

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	212953	357.4981
LAST DATA POINT:	Jun 7, 1984	205953	3812.9981

Number of points: 6912
Sampling Interval: 0.50 hrs

Minimum = -0.1641 dbar
Maximum = 0.1061 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0530 dbar

40HRLP PRESSURE RECORDS
(Fig. 8.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	060000	390.0000
LAST DATA POINT:	Jun 6, 1984	120000	3780.0000

Number of points: 566
Sampling Interval: 6.00 hrs

Minimum = -0.1364 dbar
Maximum = 0.8863 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0512 dbar

PIES84CCM3 (continued)

TEMPERATURE RECORDS
(Fig. 6.7)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1984	212953	357.4891
LAST DATA POINT:	Jun 7, 1984	205953	3812.9981

Number of points: 6912
Sampling Interval: 0.50 hrs

Minimum = 2.365 °C
Maximum = 2.494 °C
Mean = 2.397 °C
Standard deviation = 0.017 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 17, 1984	060000	390.0000
LAST DATA POINT:	Jun 6, 1984	120000	3780.0000

Number of points: 566
Sampling Interval: 6.00 hrs

Minimum = 2.367 °C
Maximum = 2.486 °C
Mean = 2.397 °C
Standard deviation = 0.016 °C

IES84D1

Serial Number: 046
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°07.79 N, 72°19.13 W — Depth: 3365 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 19, 1983	0728	CI8304
RECOVERY:	Jun 8, 1984	2328	EN118

TRAVEL TIME RECORDS
(Fig. 3.11)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 19, 1983	081114	-6159.8128
LAST DATA POINT:	Jun 8, 1984	231114	3839.1872

Number of Points: 19999
Sampling Interval: 0.50 hrs

Minimum τ = 4.45968 s — Mean = 4.48412 s
Maximum τ = 4.49795 s — Standard Deviation = 0.01135 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,ms^{-1})(\tau_d) + B$
where $B = 85504.17$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 20, 1983	180000	-6126.00
LAST DATA POINT:	Jun 7, 1984	120000	3804.00

Number of Points: 1656
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 687.33 m — Mean = 305.98 m
Maximum Z_{12} = 740.85 m — Standard Deviation = 216.94 m

IES84D2

Serial Number: 011
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°44.31 N — Depth: 3685 m
72°08.30 W

	DATE	GMT	CRUISE
LAUNCH:	Apr 25, 1983	0422	CI8304
RECOVERY:	Jun 8, 1984	1636	EN118

TRAVEL TIME RECORDS
(Fig. 3.12)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 25, 1983	053028	-6018.4922
LAST DATA POINT:	Jun 8, 1984	163028	3832.5078

Number of Points: 19703
Sampling Interval: 0.50 hrs

Minimum τ = 4.82440 s — Mean = 4.84233 s
Maximum τ = 4.86390 s — Standard Deviation = 0.01139 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,ms^{-1})(\tau_d) + B$
where B = 92492.77 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 26, 1983	120000	-5988.00
LAST DATA POINT:	Jun 7, 1984	060000	3798.00

Number of Points: 1632
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 115.50 m — Mean = 488.33 m
Maximum Z_{12} = 805.00 m — Standard Deviation = 218.62 m

IES84D3

Serial Number: 043
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°08.65 N, 71°44.45 W   Depth: 4125 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 18, 1983	1856	CI8304
RECOVERY:	Jun 8, 1984	0347	EN118

TRAVEL TIME RECORDS
(Fig. 3.13)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 18, 1983	200133	-6171.9741
LAST DATA POINT:	Jun 8, 1984	032608	3819.4356

Number of Points: 19984
Sampling Interval: 0.49999548 hrs

Minimum τ = 5.47534 s   Mean = 5.48389 s
Maximum τ = 5.49621 s   Standard Deviation = 0.00326 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,ms^{-1})(\tau_d) + B$
where B = 104953.98 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 20, 1983	060000	-6138.00
LAST DATA POINT:	Jun 6, 1984	180000	3786.00

Number of Points: 1655
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 552.50 m   Mean = 759.54 m
Maximum Z_{12} = 893.30 m   Standard Deviation = 61.52 m

IES84E1

Serial Number: 047
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°23.13 N
71°38.89 W

Depth: 3600 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 23, 1983	0240	CI8304
RECOVERY:	Jun 12, 1984	1723	EN118

TRAVEL TIME RECORDS
(Fig. 3.14)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 23, 1983	035433	-6068.0908
LAST DATA POINT:	Jun 12, 1984	171904	3929.3178

Number of Points: 19996
Sampling Interval: 0.49999543 hrs

Minimum τ = 4.75069 s
Maximum τ = 4.78800 s

Mean = 4.77517 s
Standard Deviation = 0.01114 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.4)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 91036.13 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 24, 1983	120000	-6036.00
LAST DATA POINT:	Jun 11, 1984	120000	3900.00

Number of Points: 1657
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 84.11 m
Maximum Z_{12} = 748.26 m

Mean = 307.85 m
Standard Deviation = 214.36 m

IES84E2

Serial Number: 044
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°52.98 N Depth: 4115 m
71°21.85 W

	DATE	GMT	CRUISE
LAUNCH:	Apr 22, 1983	2022	CI8304
RECOVERY:	Jun 11, 1984	2304	EN118

TRAVEL TIME RECORDS
(Fig. 3.15)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 22, 1983	213508	-6074.4144
LAST DATA POINT:	Jun 11, 1984	225633	3910.9424

Number of Points: 19972
Sampling Interval: 0.49999283 hrs

Minimum τ = 5.45601 s Mean = 5.47194 s
Maximum τ = 5.49581 s Standard Deviation = 0.01156 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.4)

Z_{12} Conversion Equation: $Z_{12} = (-19000 \text{ms}^{-1})(\tau_d) + B$
where B = 104512.60 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 24, 1983	060000	-6042.00
LAST DATA POINT:	Jun 10, 1984	120000	3872.00

Number of Points: 1654
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 113.65 m Mean = 545.35 m
Maximum Z_{12} = 821.41 m Standard Deviation = 221.72 m

IES84E3

Serial Number: 045
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°23.11 N, 71°04.64 W   Depth: 4320 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 22, 1983	1344	CI8304
RECOVERY:	Jun 8, 1984	0834	EN118

TRAVEL TIME RECORDS
(Fig. 3.16)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 22, 1983	143829	-6081.3586
LAST DATA POINT:	Jun 8, 1984	082815	3824.4708

Number of Points: 19813
Sampling Interval: 0.49999139 hrs

Minimum τ = 5.73065 s   Mean = 5.73992 s
Maximum τ = 5.76060 s   Standard Deviation = 0.00476 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.4)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,\mathrm{ms}^{-1})(\tau_d) + B$
where B = 109786.05 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 24, 1983	000000	-6048.00
LAST DATA POINT:	Jun 7, 1984	000000	3792.00

Number of Points: 1641
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 370.74 m   Mean = 726.91 m
Maximum Z_{12} = 883.93 m   Standard Deviation = 90.85 m

IES84F1

Serial Number: 048
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°37.42 N, 71°00.02 W   Depth: 3982 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 21, 1983	1600	CI8304
RECOVERY:	Jun 12, 1984	1022	EN118

TRAVEL TIME RECORDS
(Fig. 3.17)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 21, 1983	164902	-6103.1828
LAST DATA POINT:	Jun 12, 1984	101405	3922.2347

Number of Points: 20052
Sampling Interval: 0.499995884 hrs

Minimum τ = 5.27721 s   Mean = 5.30096 s
Maximum τ = 5.31342 s   Standard Deviation = 0.00928 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,ms^{-1})(\tau_d) + B$
where B = 101014.72 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 23, 1983	000000	-6072.00
LAST DATA POINT:	Jun 11, 1984	000000	3888.00

Number of Points: 1661
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 87.67 m   Mean = 296.33 m
Maximum Z_{12} = 719.78 m   Standard Deviation = 179.62 m

IES84F2

Serial Number: 020
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°08.11 N, 70°43.02 W Depth: 4205 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 21, 1983	2308	CI8304
RECOVERY:	Jun 12, 1984	0413	EN118

TRAVEL TIME RECORDS
(Fig. 3.18)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 22, 1983	000038	-6095.9894
LAST DATA POINT:	Jun 12, 1984	023038	3914.5106

Number of Points: 20022
Sampling Interval: 0.50 hrs

Minimum τ = 5.59112 s Mean = 5.60772 s
Maximum τ = 5.63137 s Standard Deviation = 0.01214 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 107096.76 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 23, 1983	060000	-6066.00
LAST DATA POINT:	Jun 10, 1984	180000	3882.00

Number of Points: 1659
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 123.12 m Mean = 549.69 m
Maximum Z_{12} = 845.41 m Standard Deviation = 230.91 m

IES84F3

Serial Number: 023
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°37.96 N
70°24.76 W
Depth: 4420 m

	DATE	GMT	CRUISE
LAUNCH:	Apr 22, 1983	0615	CI8304
RECOVERY:	Jun 14, 1984	1424	EN118

TRAVEL TIME RECORDS
(Fig. 3.19)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 22, 1983	074147	-6088.3036
LAST DATA POINT:	Jun 14, 1984	141147	3974.1964

Number of Points: 20126
Sampling Interval: 0.50 hrs

Minimum τ = 5.83096 s
Maximum τ = 5.86860 s
Mean = 5.84102 s
Standard Deviation = 0.00569 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,\mathrm{ms}^{-1})(\tau_d) + B$
where B = 111712.39 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Apr 23, 1983	180000	-6054.00
LAST DATA POINT:	Jun 13, 1984	060000	3942.00

Number of Points: 1667
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 241.16 m
Maximum Z_{12} = 912.55 m
Mean = 732.15 m
Standard Deviation = 117.25 m

IES84G1

Serial Number: 019
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°53.46 N 70°18.99 W   Depth: 3855 m

	DATE	GMT	CRUISE
LAUNCH:	Sep 27, 1983	0409	EN106
RECOVERY:	Jun 15, 1984	0936	EN118

TRAVEL TIME RECORDS
(Fig. 3.20)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 27, 1983	055132	-2298.1411
LAST DATA POINT:	Jun 15, 1984	092132	3993.3589

Number of Points: 12584
Sampling Interval: 0.50 hrs

Minimum τ = 5.10514 s   Mean = 5.12151 s
Maximum τ = 5.13533 s   Standard Deviation = 0.00730 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,\mathrm{ms}^{-1})(\tau_d) + B$
where $B = 97648.16$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 28, 1983	120000	-2268.00
LAST DATA POINT:	Jun 14, 1984	000000	3960.00

Number of Points: 1039
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 104.86 m   Mean = 339.31 m
Maximum Z_{12} = 639.81 m   Standard Deviation = 138.26 m

IES84G2

Serial Number: 016
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°23.55 N, 70°03.72 W   Depth: 4220 m

	DATE	GMT	CRUISE
LAUNCH:	Sep 26, 1983	2320	EN106
RECOVERY:	Jun 15, 1984	0249	EN118

TRAVEL TIME RECORDS
(Fig. 3.21)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 27, 1983	001712	-2303.7133
LAST DATA POINT:	Jun 15, 1984	024712	3986.7867

Number of Points: 12582
Sampling Interval: 0.50 hrs

Minimum τ = 5.60768 s   Mean = 5.61760 s
Maximum τ = 5.64421 s   Standard Deviation = 0.00695 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where $B = 107369.86$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 28, 1983	060000	-2274.00
LAST DATA POINT:	Jun 13, 1984	180000	3954.00

Number of Points: 1039
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 140.40 m   Mean = 634.93 m
Maximum Z_{12} = 791.06 m   Standard Deviation = 135.08 m

IES84G3

Serial Number: 015
Type of Travel Time Detector: TTB
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°52.34 N 69°44.90 W   Depth: 4373 m

	DATE	GMT	CRUISE
LAUNCH:	Sep 26, 1983	1827	EN106
RECOVERY:	Jun 14, 1984	2016	EN118

TRAVEL TIME RECORDS
(Fig. 3.22)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 26, 1983	194313	-2308.2797
LAST DATA POINT:	Jun 14, 1984	201313	3980.2203

Number of Points: 12578
Sampling Interval: 0.50 hrs

Minimum τ = 5.80866 s   Mean = 5.81469 s
Maximum τ = 5.82762 s   Standard Deviation = 0.00327 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 111240.86 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Sep 28, 1983	060000	-2274.00
LAST DATA POINT:	Jun 13, 1984	120000	3948.00

Number of Points: 1038
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 529.41 m   Mean = 760.75 m
Maximum Z_{12} = 863.23 m   Standard Deviation = 65.52 m

SECTION 3

Half-hourly Data For Each Instrument

Plots of the travel time records from each instrument are presented first. These are followed by the measured and residual pressure records and the temperature data for the instruments which had those additional sensors.

The time scale is the same for all plots, with each increment corresponding to 5 days. The axis begins on 0000 GMT of the first date labelled.

Vertical scale for each variable is consistent between instruments. Each increment corresponds to 5 msec for the travel time records, 0.5 dbar for the bottom pressure measurements, 0.05 dbar for the residual bottom pressure data, and 0.02°C for the temperatures.

The sampling interval is nominally 0.5 hours; the actual interval for each instrument is listed in Section 2. The length and the start and end times of the data records are also tabulated in the previous section.

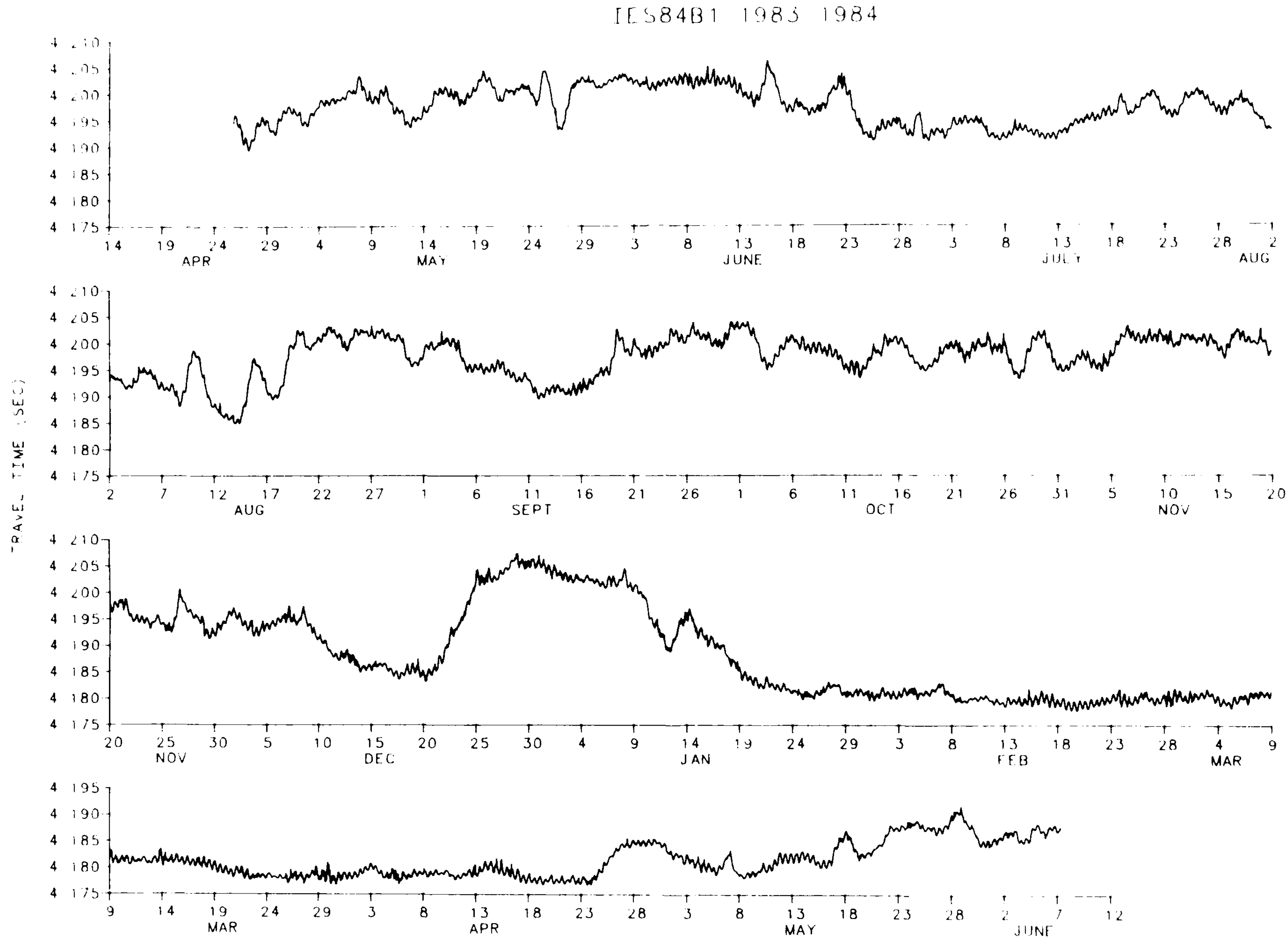


Figure 3.1

Figure 3.1-22. Full travel time records for each IES at half-hourly intervals.

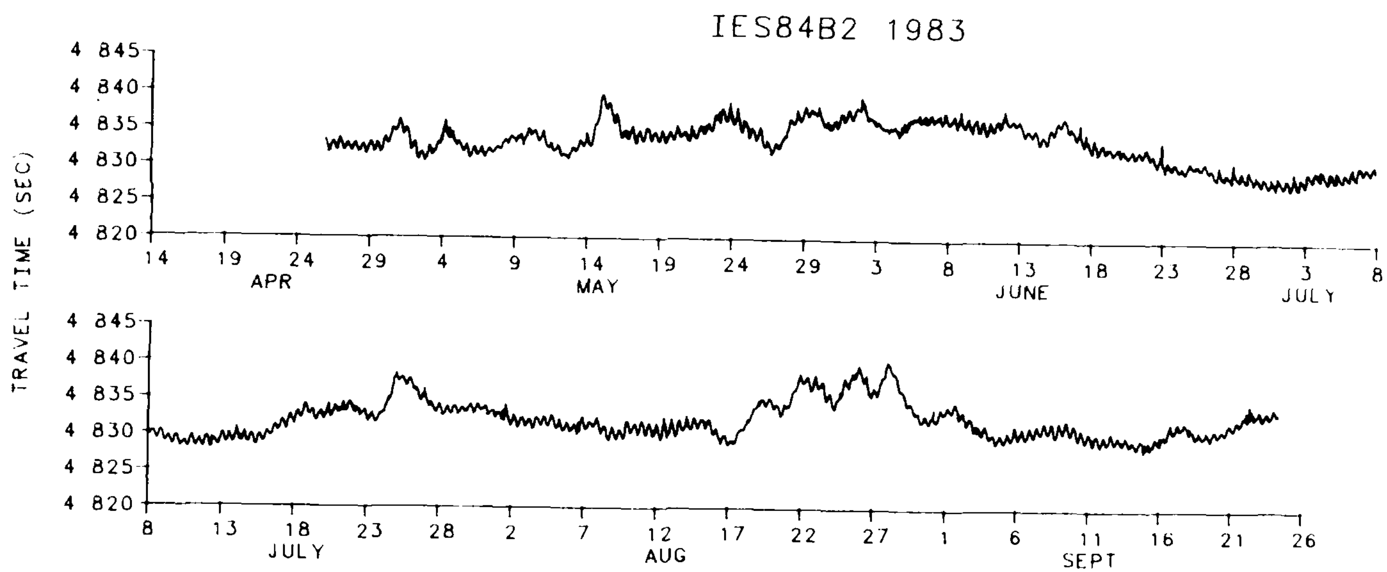

IES84B2 1983
TRAVEL TIME (SEC)
4 845
4 840
4 835
4 830
4 825
4 820
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8
APR
MAY
JUNE
JULY
8 13 18 23 28 2 7 12 17 22 27 1 6 11 16 21 26
JULY
AUG
SEPT

Figure 3.2

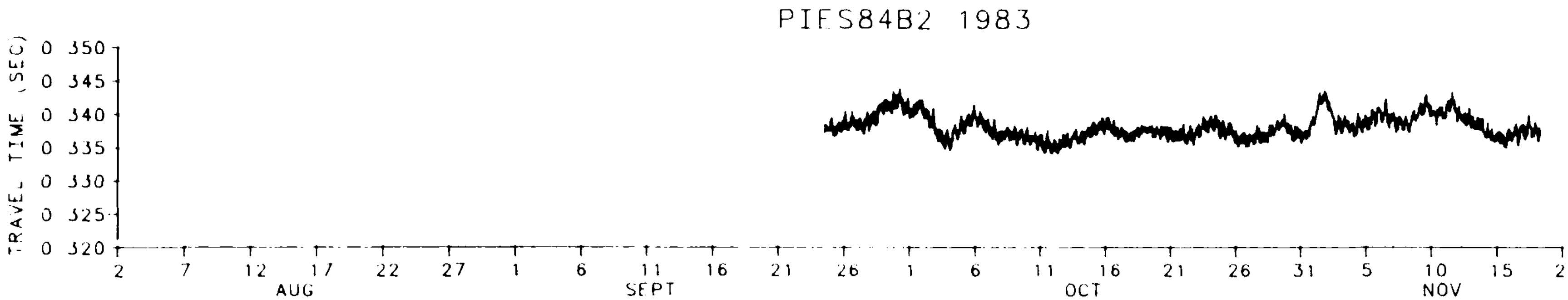

PIES84B2 1983
TRAVEL TIME (SEC)
0.350
0.345
0.340
0.335
0.330
0.325
0.320
2
7
12
17
22
27
1
6
11
16
21
26
1
6
11
16
21
26
31
5
10
15
20
AUG
SEPT
OCT
NOV

Figure 3.3

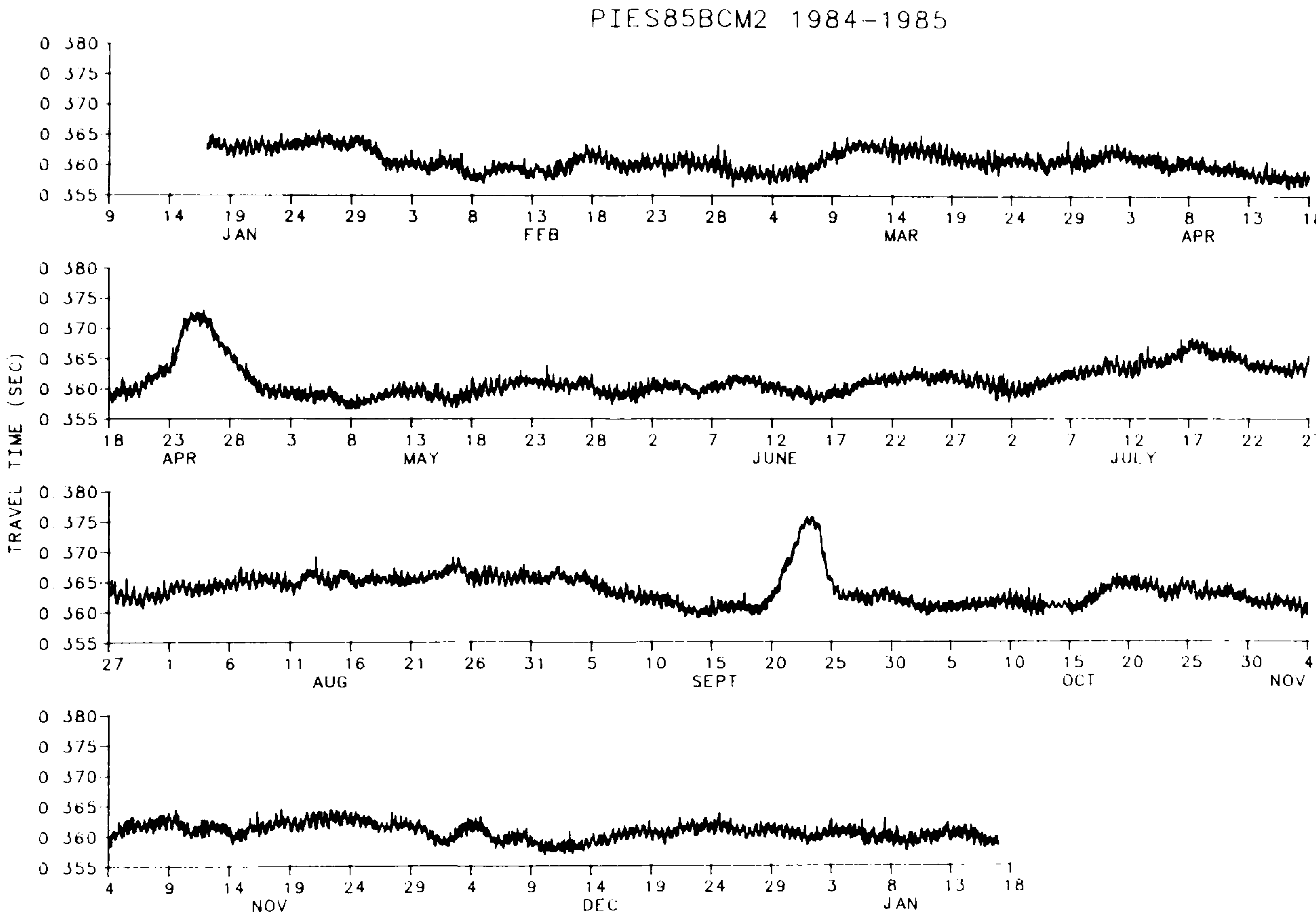

PIES85BCM2 1984-1985
TRAVEL TIME (SEC)
0.380
0.375
0.370
0.365
0.360
0.355
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN

Figure 3.4

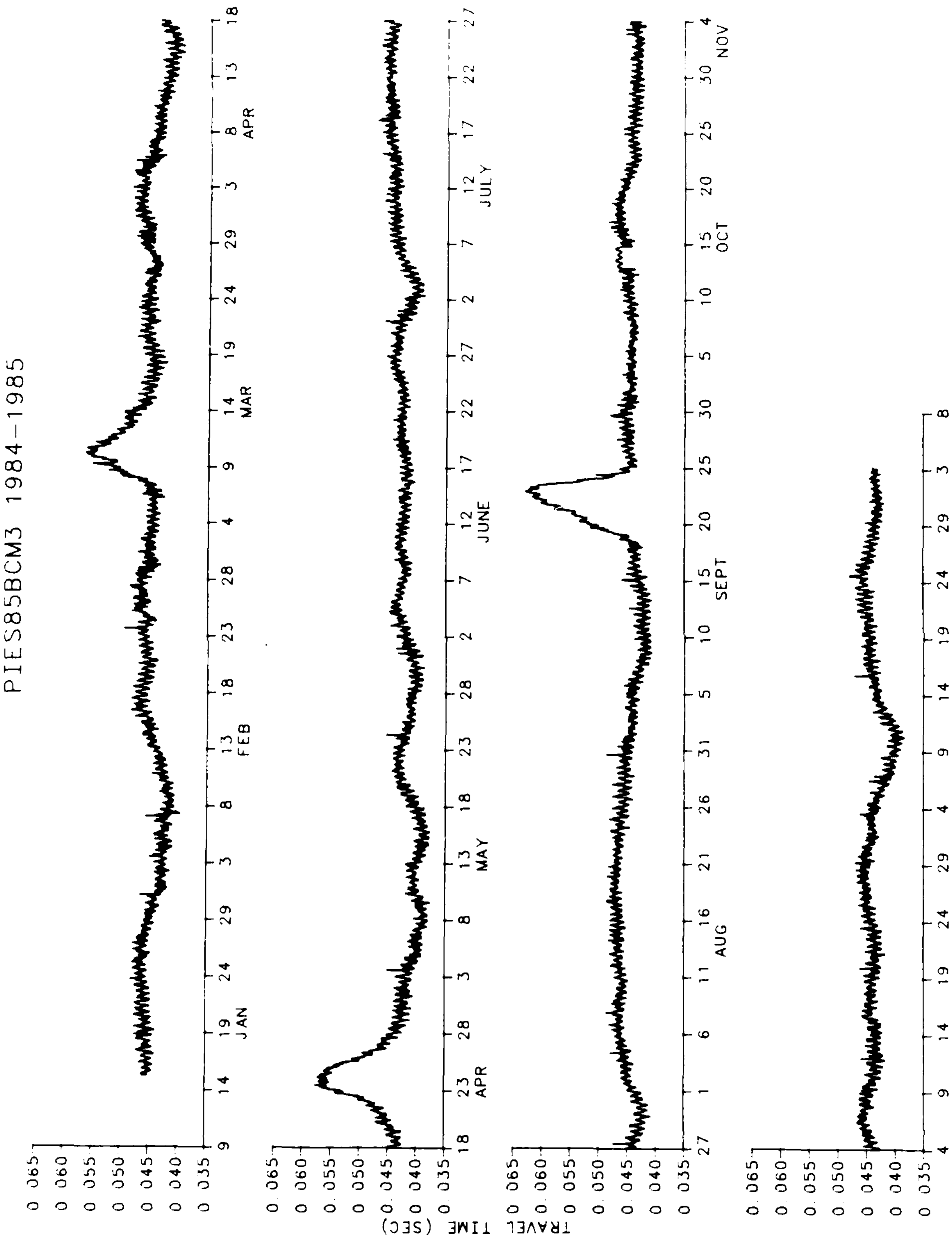

PIES85BCM3 1984-1985
TRAVEL TIME (SEC)
0.065
0.060
0.055
0.050
0.045
0.040
0.035
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN

Figure 3.5

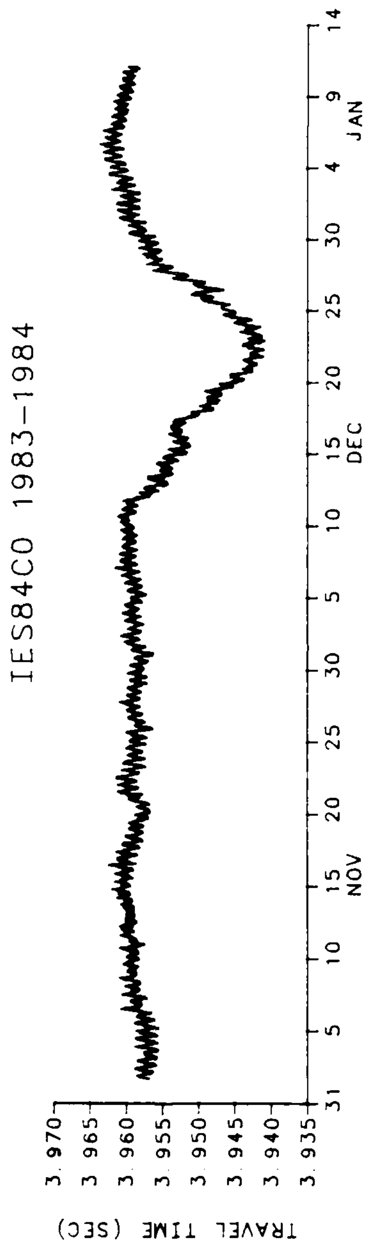

IES84CO 1983-1984
TRAVEL TIME (SEC)
3.970
3.965
3.960
3.955
3.950
3.945
3.940
3.935
31
5
10
15
NOV
20
25
30
5
10
15
DEC
20
25
30
4
9
JAN
14

Figure 3.6

PIES84C1 1983–1984

Figure 3.7

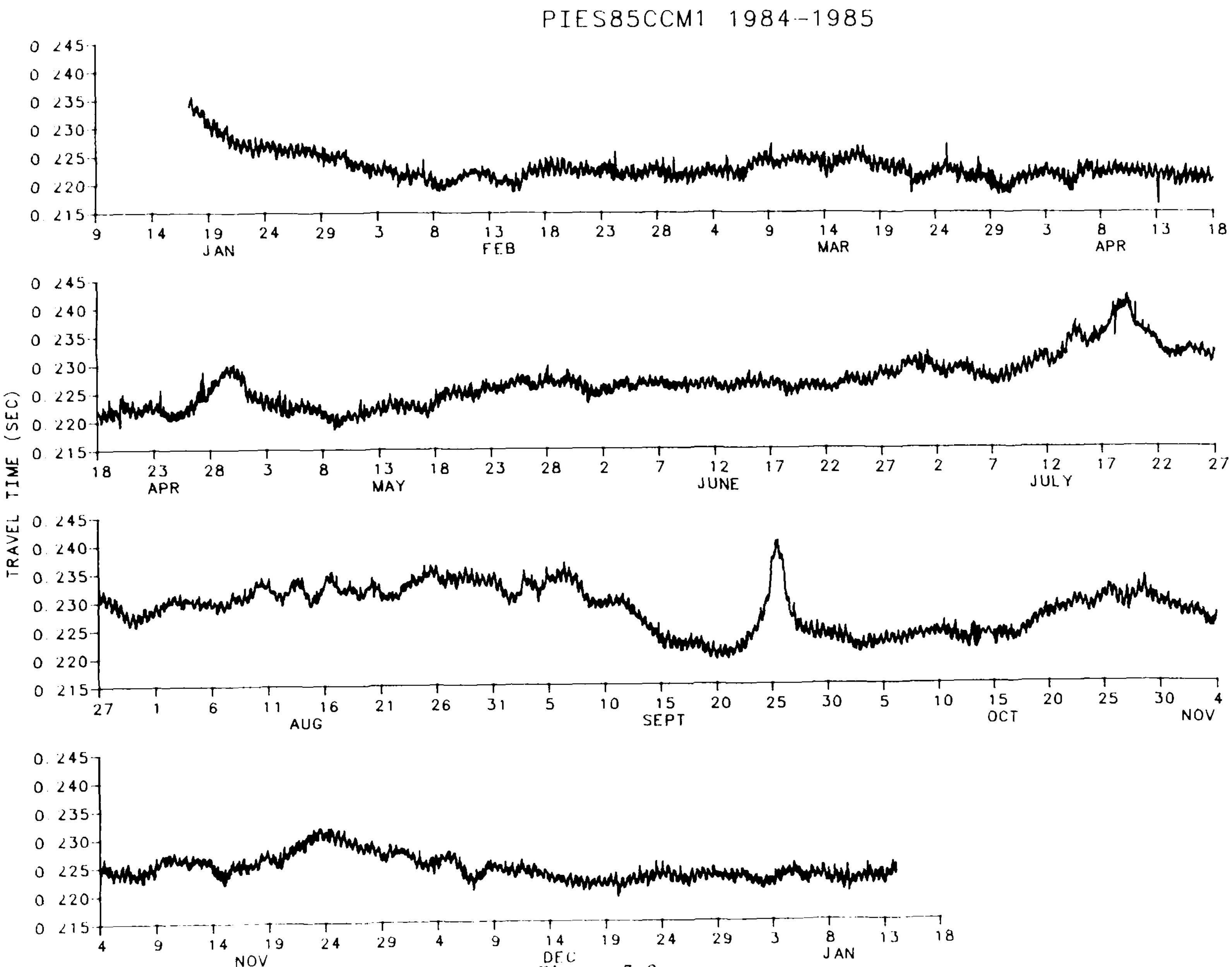

PIES85CCM1 1984-1985
TRAVEL TIME (SEC)
0.245
0.240
0.235
0.230
0.225
0.220
0.215
9 14 19 24 29 3 8 13 18 23 28 4 9 14 19 24 29 3 8 13 18
JAN
FEB
MAR
APR
18 23 28 3 8 13 18 23 28 2 7 12 17 22 27 2 7 12 17 22 27
APR
MAY
JUNE
JULY
27 1 6 11 16 21 26 31 5 10 15 20 25 30 5 10 15 20 25 30 4
AUG
SEPT
OCT
NOV
4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18
NOV
DEC
JAN

Figure 3.8

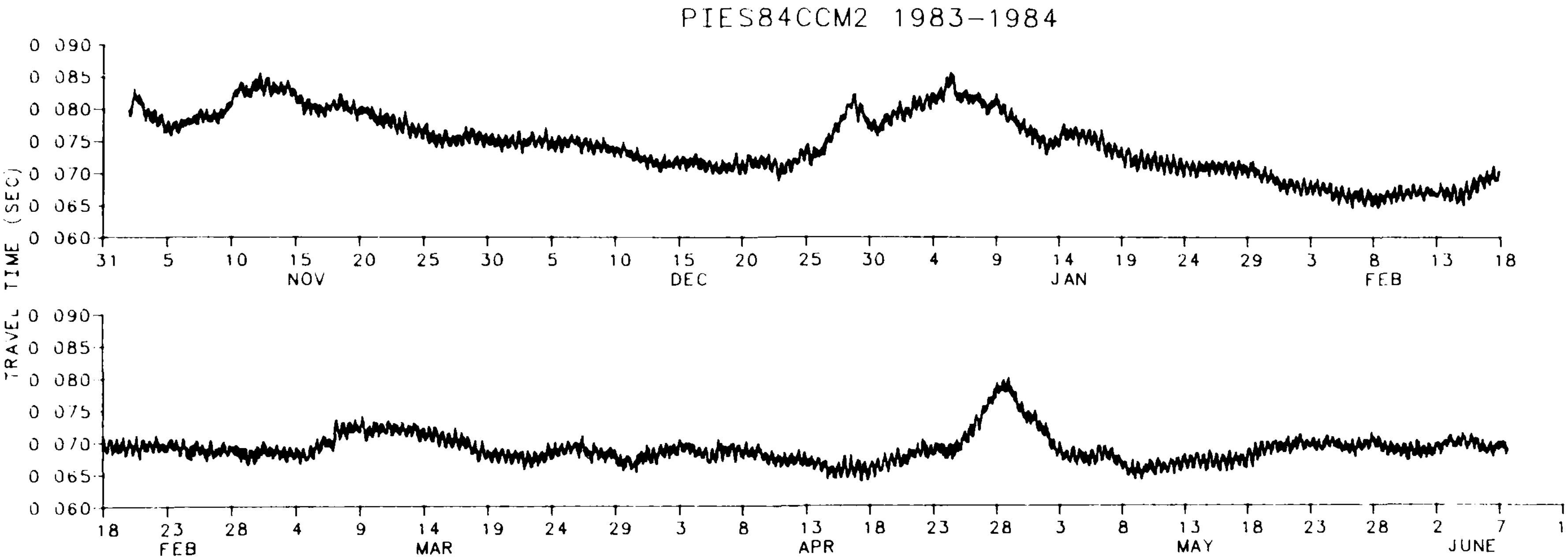
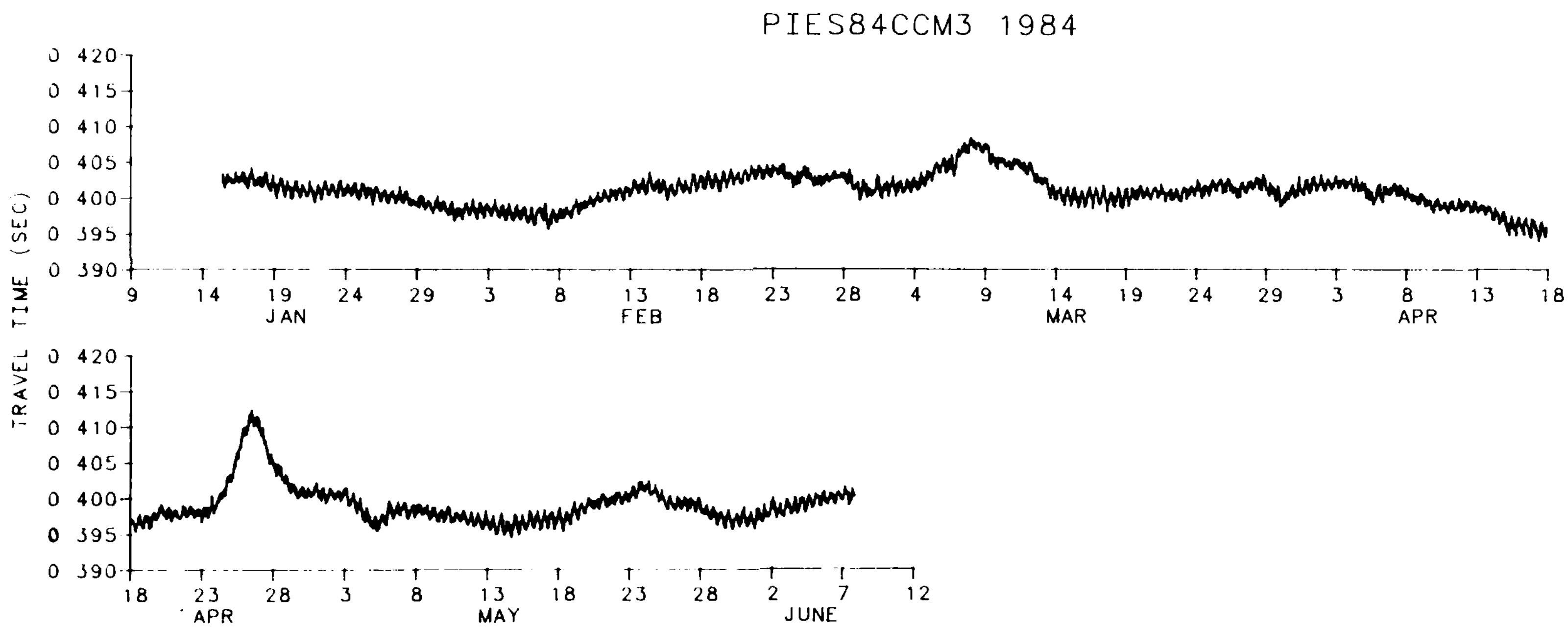

PIES84CCM2 1983-1984
TRAVEL TIME (SEC)
0.090
0.085
0.080
0.075
0.070
0.065
0.060
31 5 10 15 20 25 30 5 10 15 20 25 30 4 9 14 19 24 29 3 8 13 18
NOV
DEC
JAN
FEB
18 23 28 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2 7 12
FEB
MAR
APR
MAY
JUNE

Figure 3.9



PIES84CCM3 1984
TRAVEL TIME (SEC)
0 420
0 415
0 410
0 405
0 400
0 395
0 390
9
14
19
JAN
24
29
3
8
13
FEB
18
23
28
4
9
14
MAR
19
24
29
3
8
APR
13
18
23
APR
28
3
8
13
MAY
18
23
28
2
7
JUNE
12

Figure 3.10

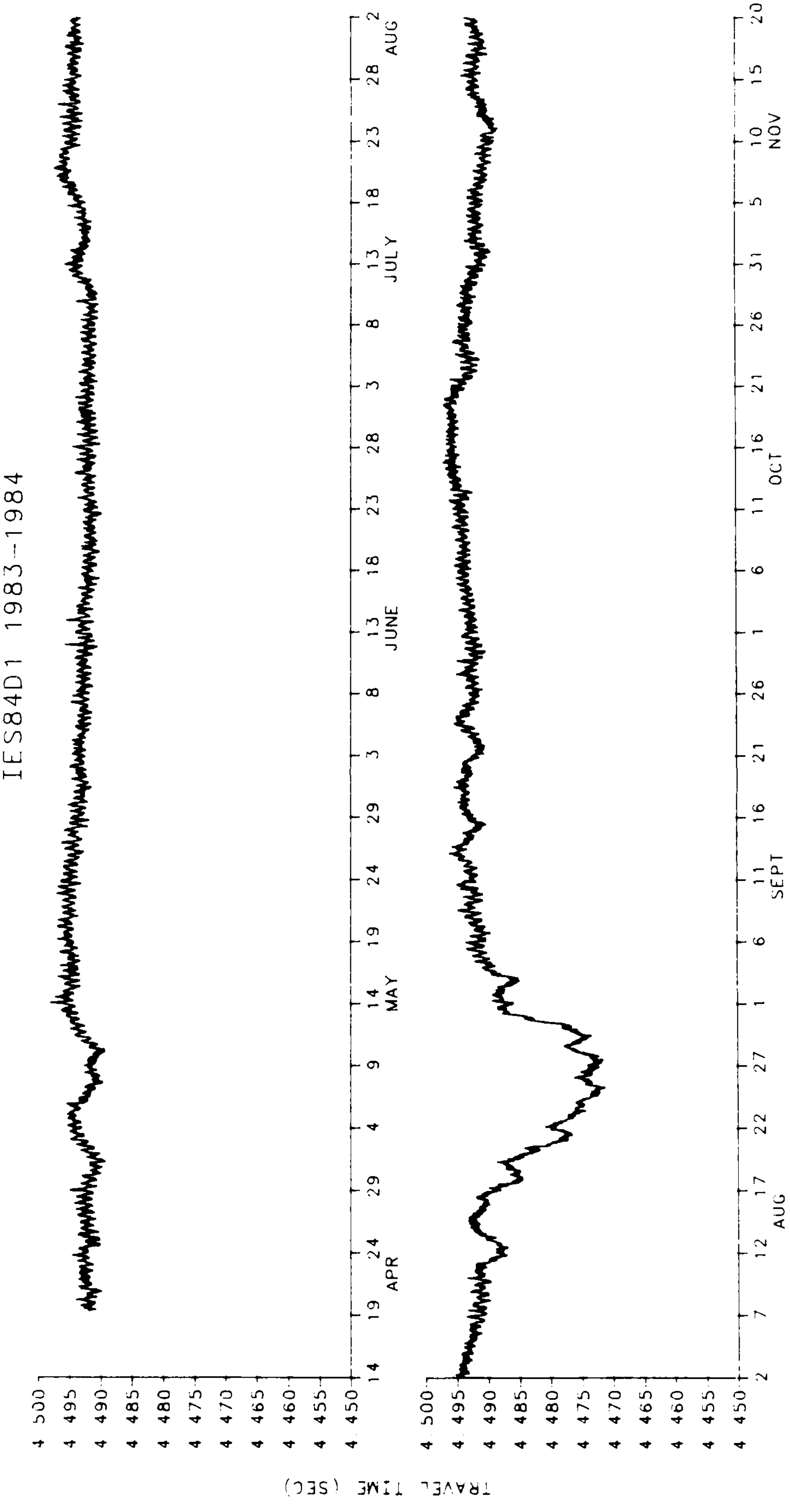

IES84D1 1983-1984
TRAVEL TIME (SEC)
4 500
4 495
4 490
4 485
4 480
4 475
4 470
4 465
4 460
4 455
4 450
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR MAY JUNE JULY AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG SEPT OCT NOV

Figure 3.11

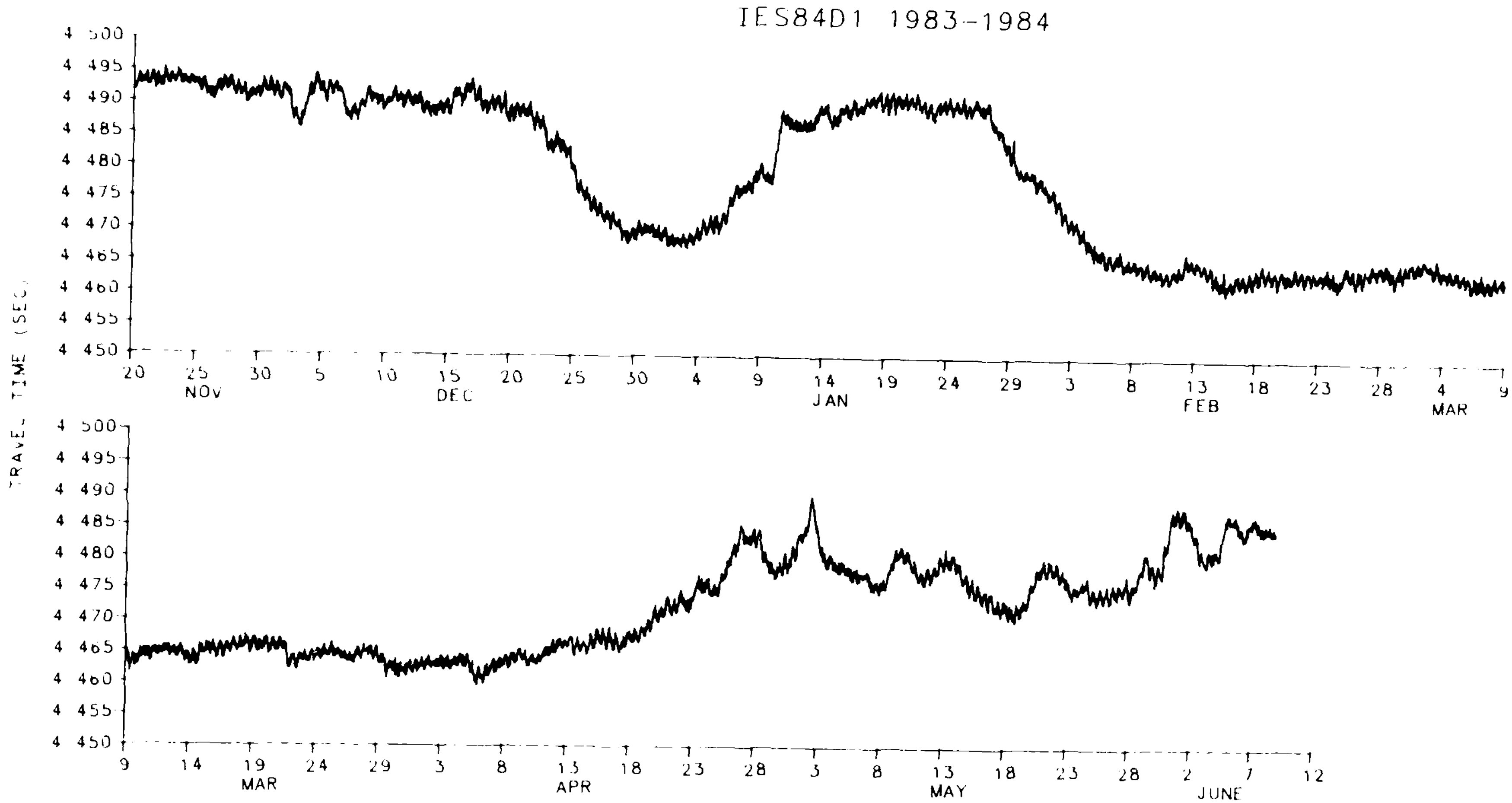


Figure 3.11 (continued)

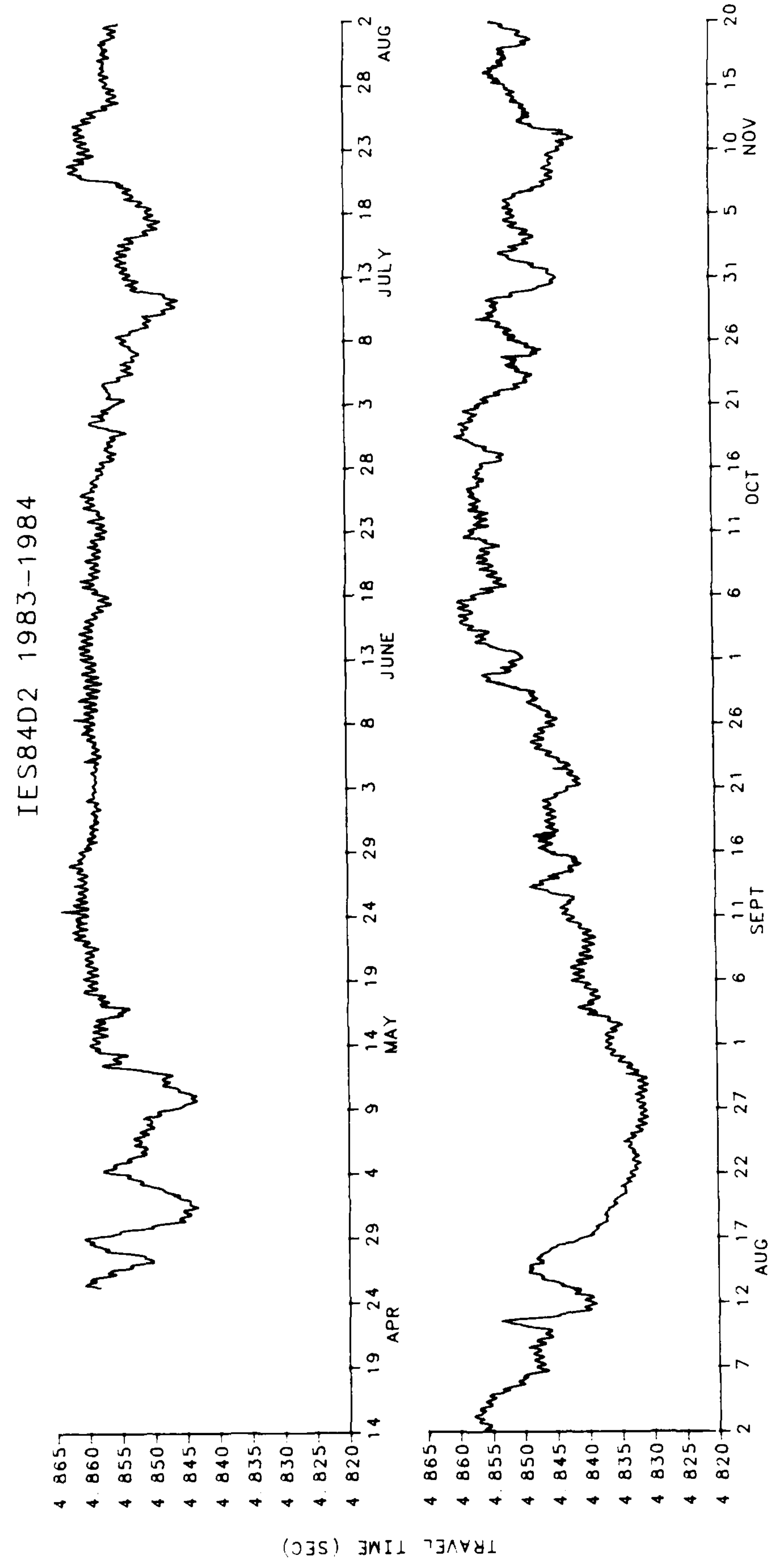

IES84D2 1983-1984
TRAVEL TIME (SEC)
4 865
4 860
4 855
4 850
4 845
4 840
4 835
4 830
4 825
4 820
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR MAY JUNE JULY AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG SEPT OCT NOV

Figure 3.12

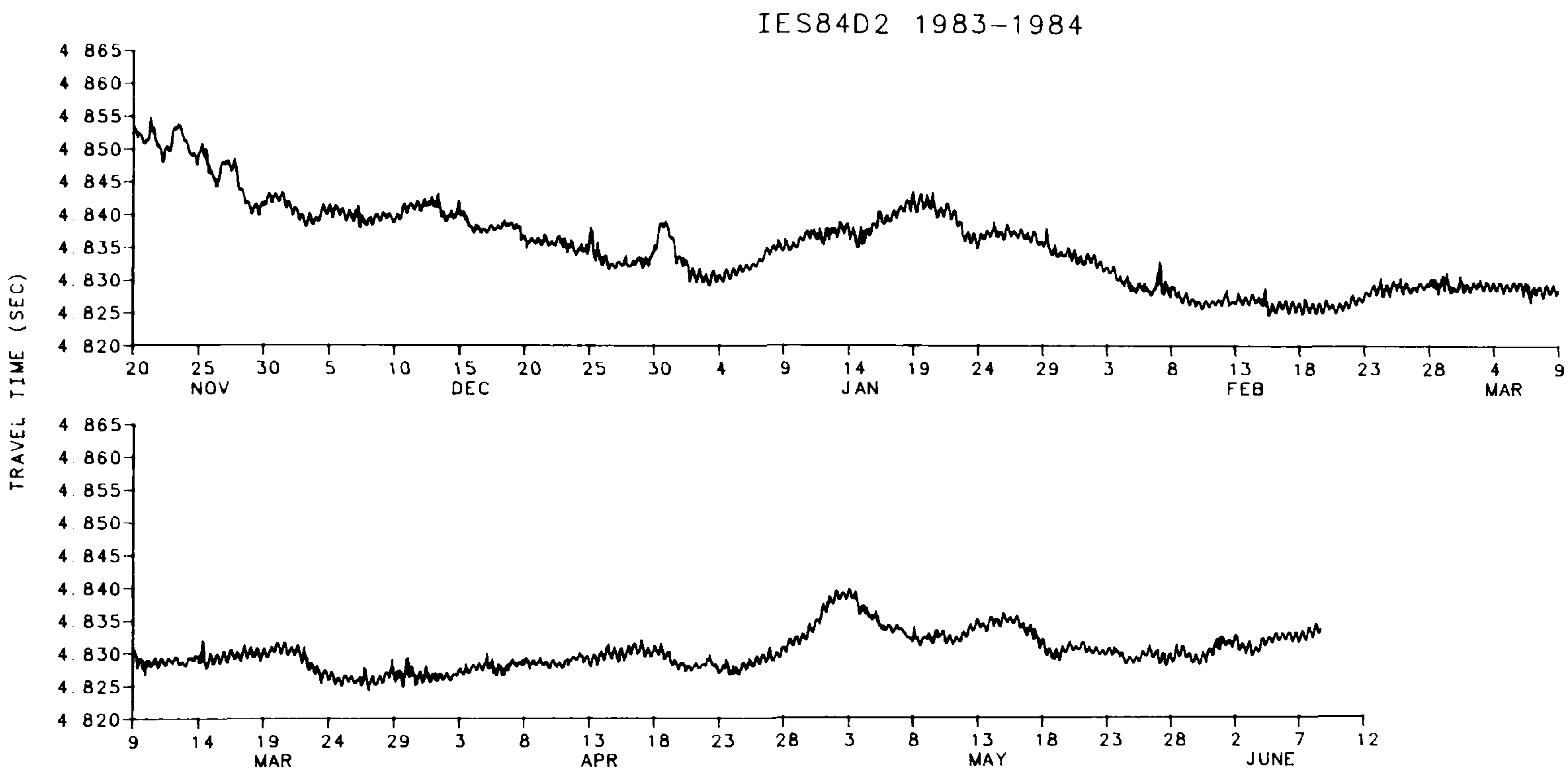
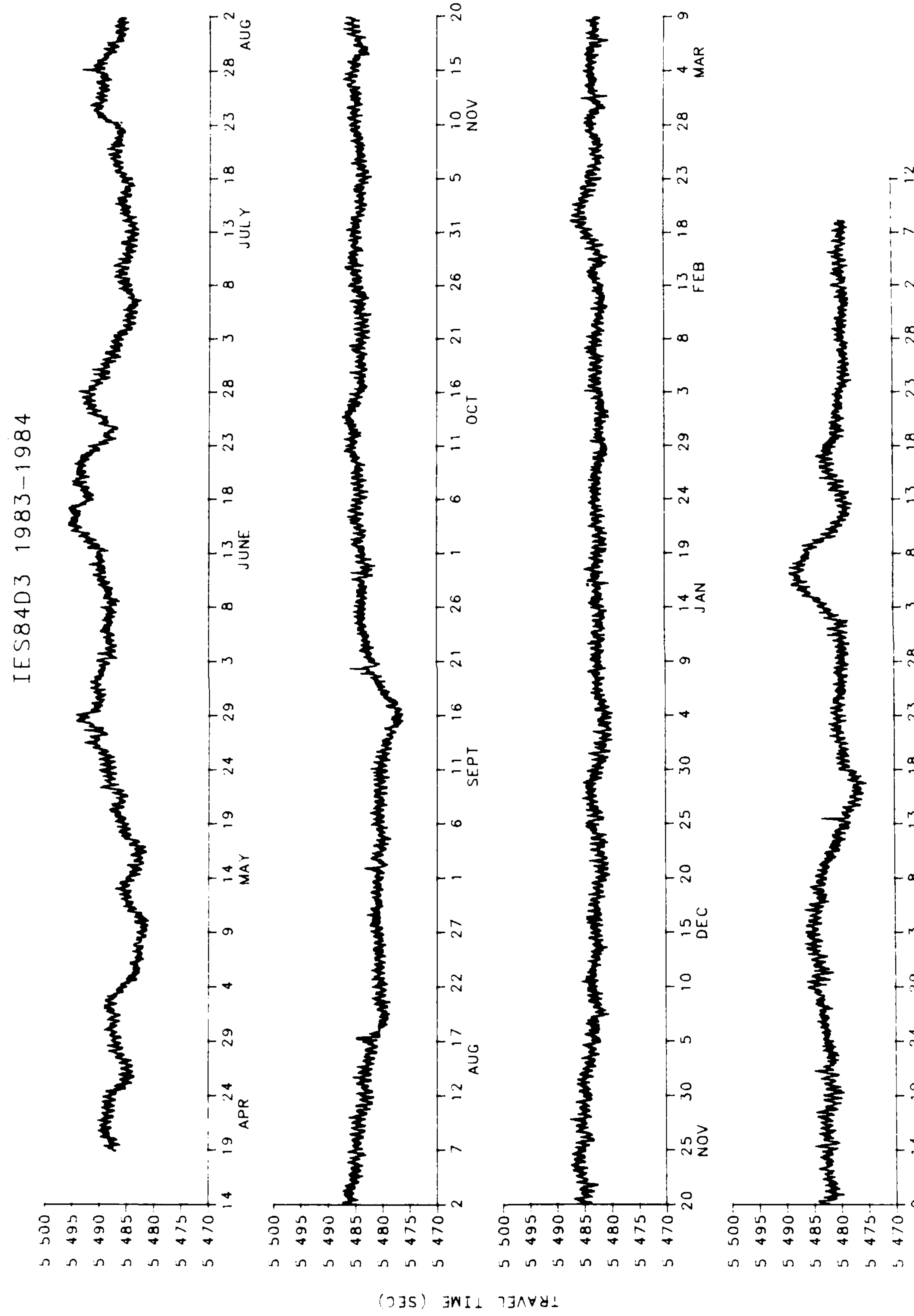


Figure 3.12 (continued)



IES84D3 1983-1984
TRAVEL TIME (SEC)
5.500
5.495
5.490
5.485
5.480
5.475
5.470
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE

Figure 3.13

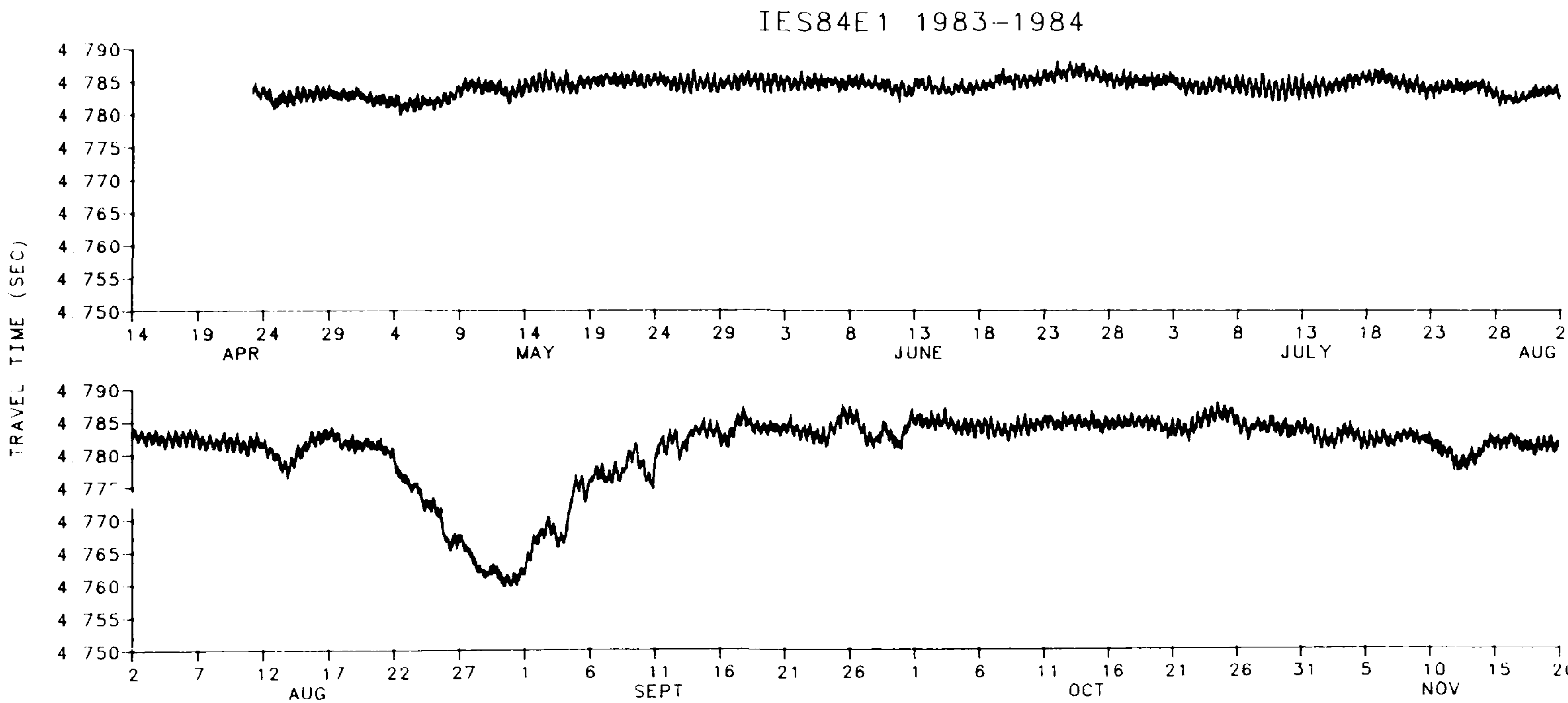

IES84E1 1983-1984
TRAVEL TIME (SEC)
4 790
4 785
4 780
4 775
4 770
4 765
4 760
4 755
4 750
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR
MAY
JUNE
JULY
AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG
SEPT
OCT
NOV

Figure 3.14

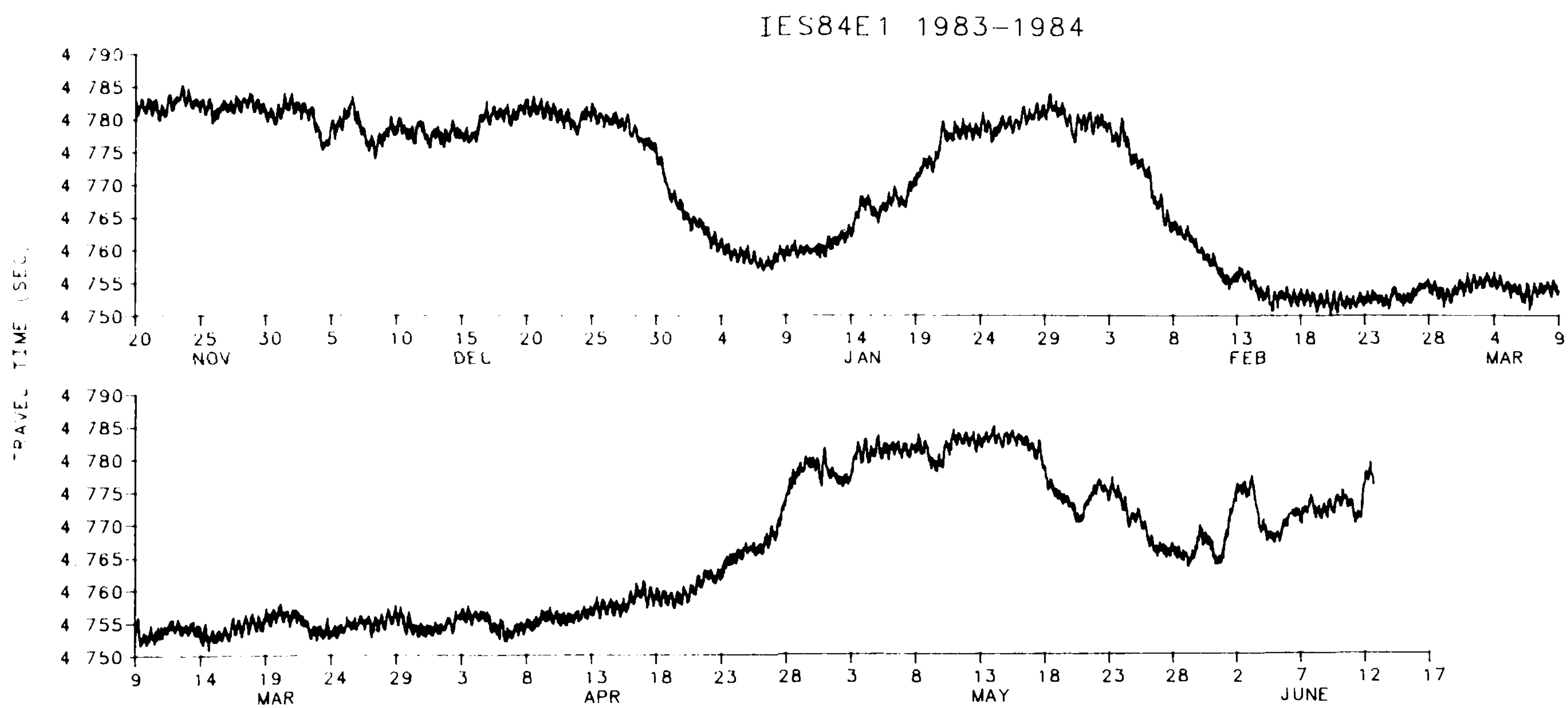
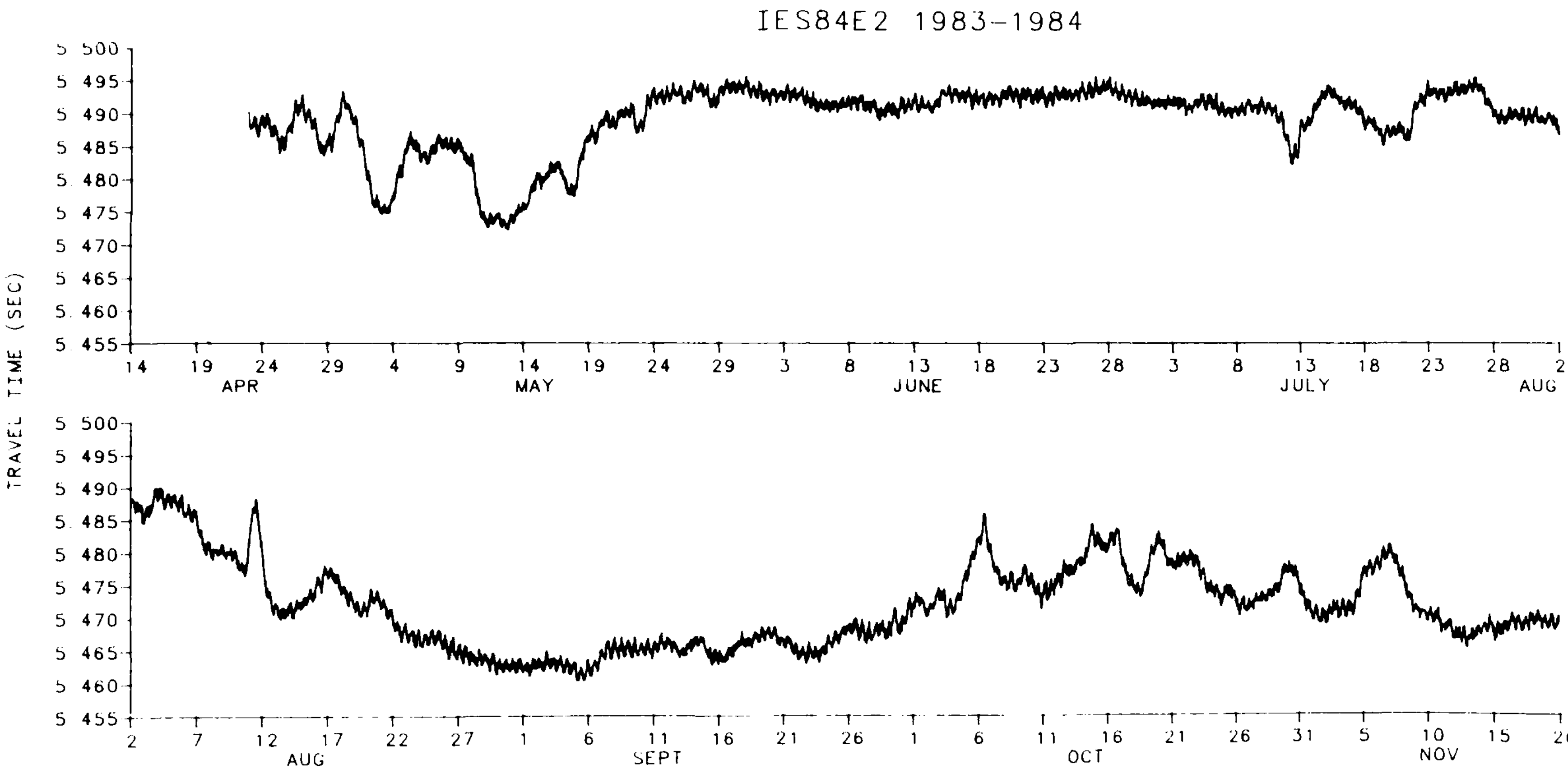


Figure 3.14 (continued)



IES84E2 1983-1984
TRAVEL TIME (SEC)
5.500
5.495
5.490
5.485
5.480
5.475
5.470
5.465
5.460
5.455
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR
MAY
JUNE
JULY
AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG
SEPT
OCT
NOV

Figure 3.15

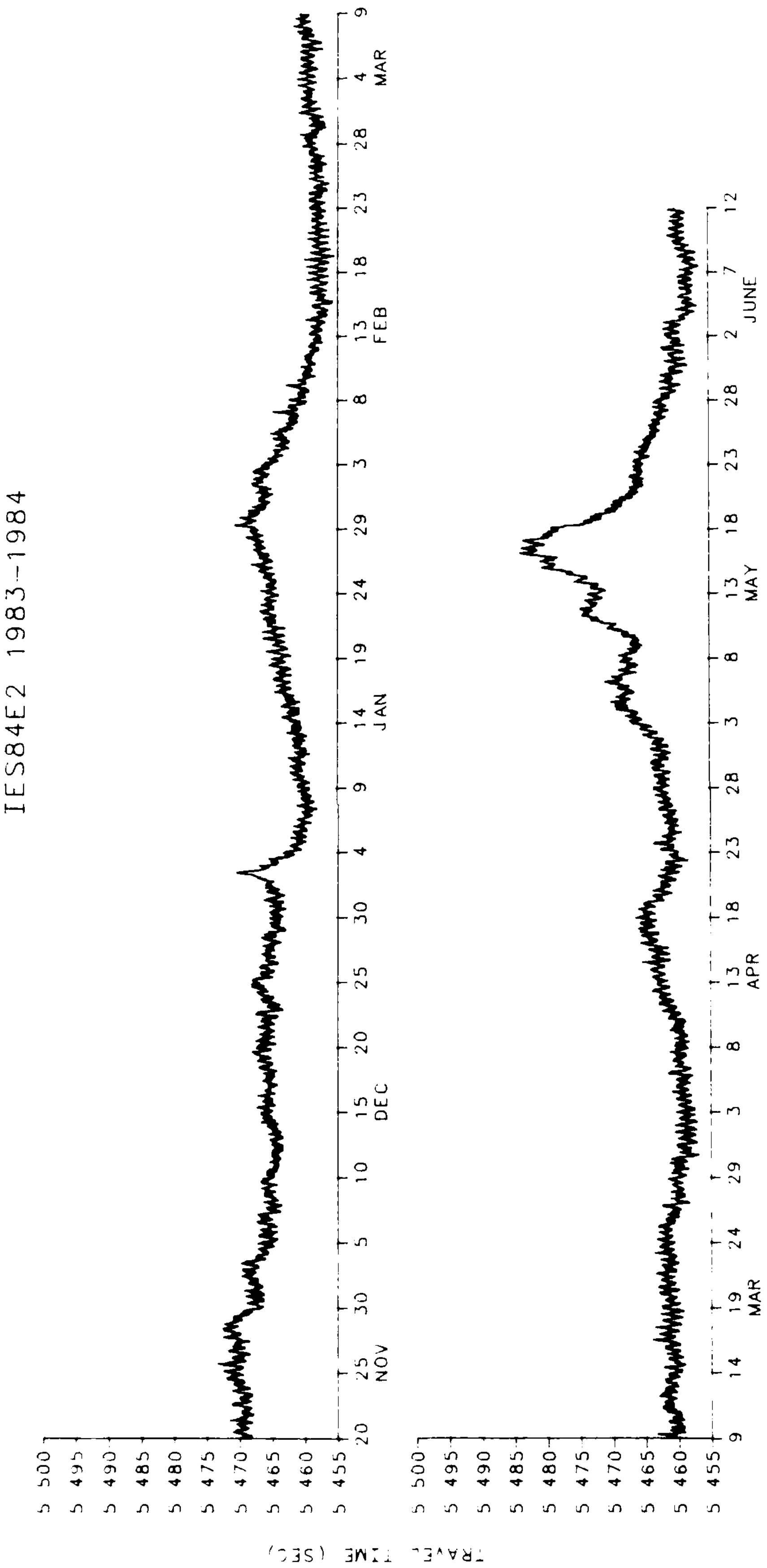


Figure 3.15 (continued)

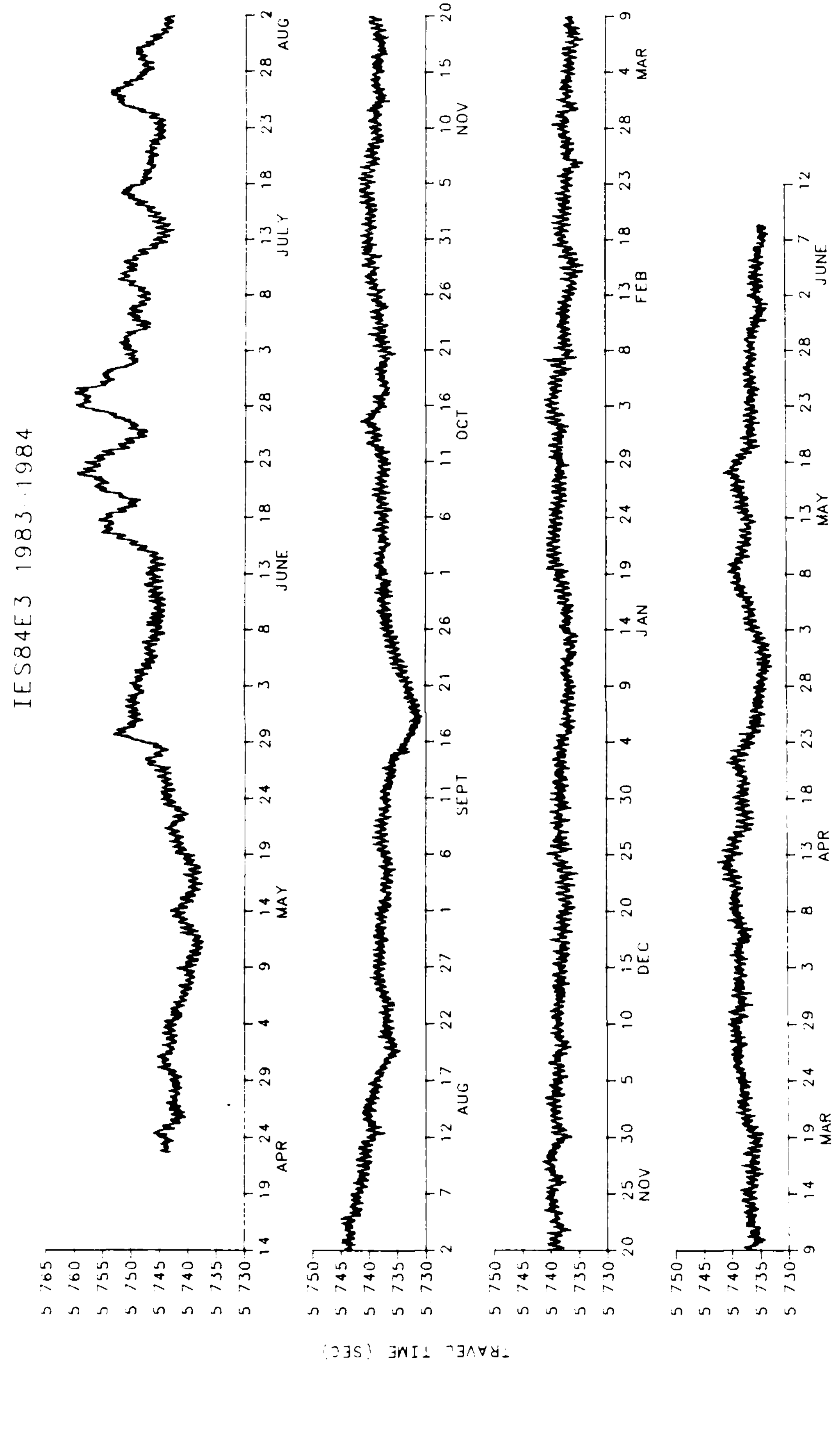
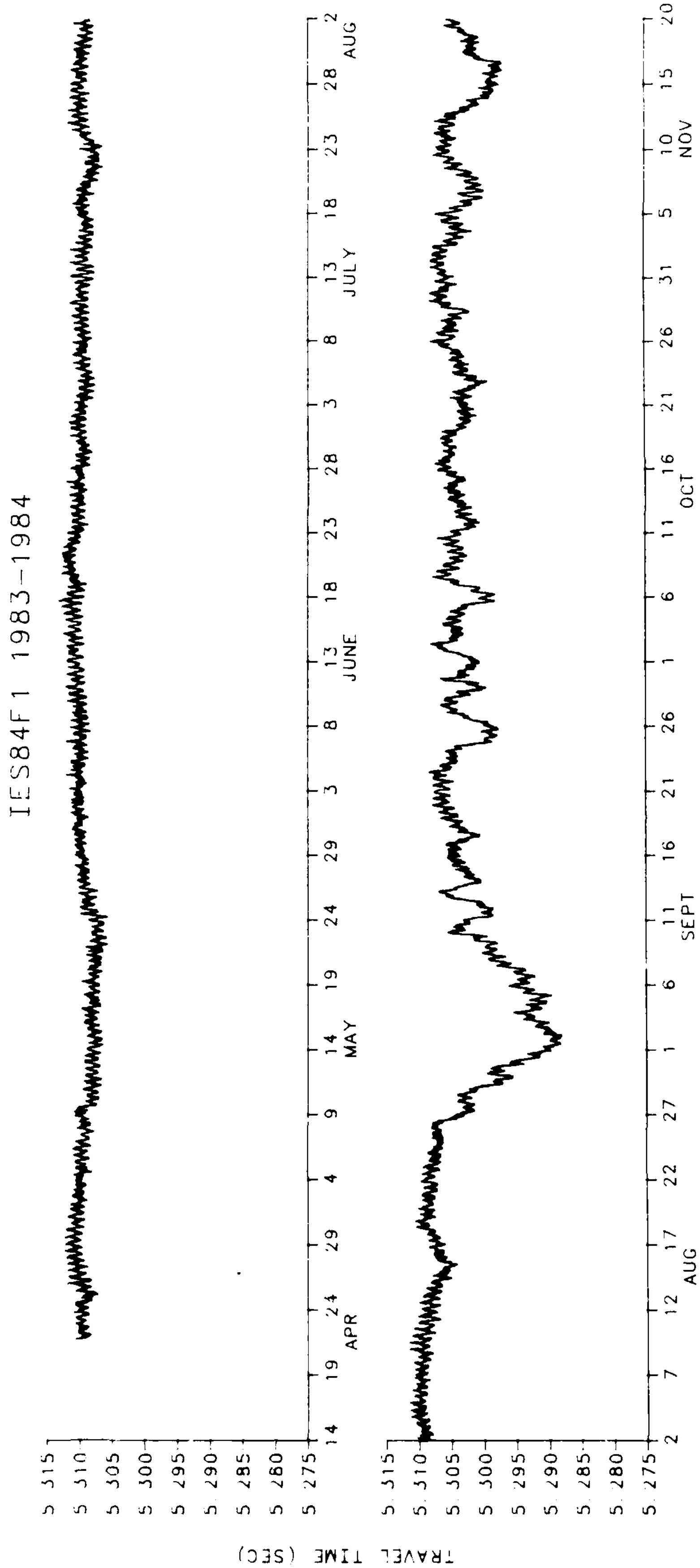

IES84E3 1983-1984
TRAVEL TIME (SEC)
5.765
5.760
5.755
5.750
5.745
5.740
5.735
5.730
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE

Figure 3.16



IES84F1 1983-1984
TRAVEL TIME (SEC)
5.315
5.310
5.305
5.300
5.295
5.290
5.285
5.280
5.275
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR MAY JUNE JULY AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG SEPT OCT NOV

Figure 3.17

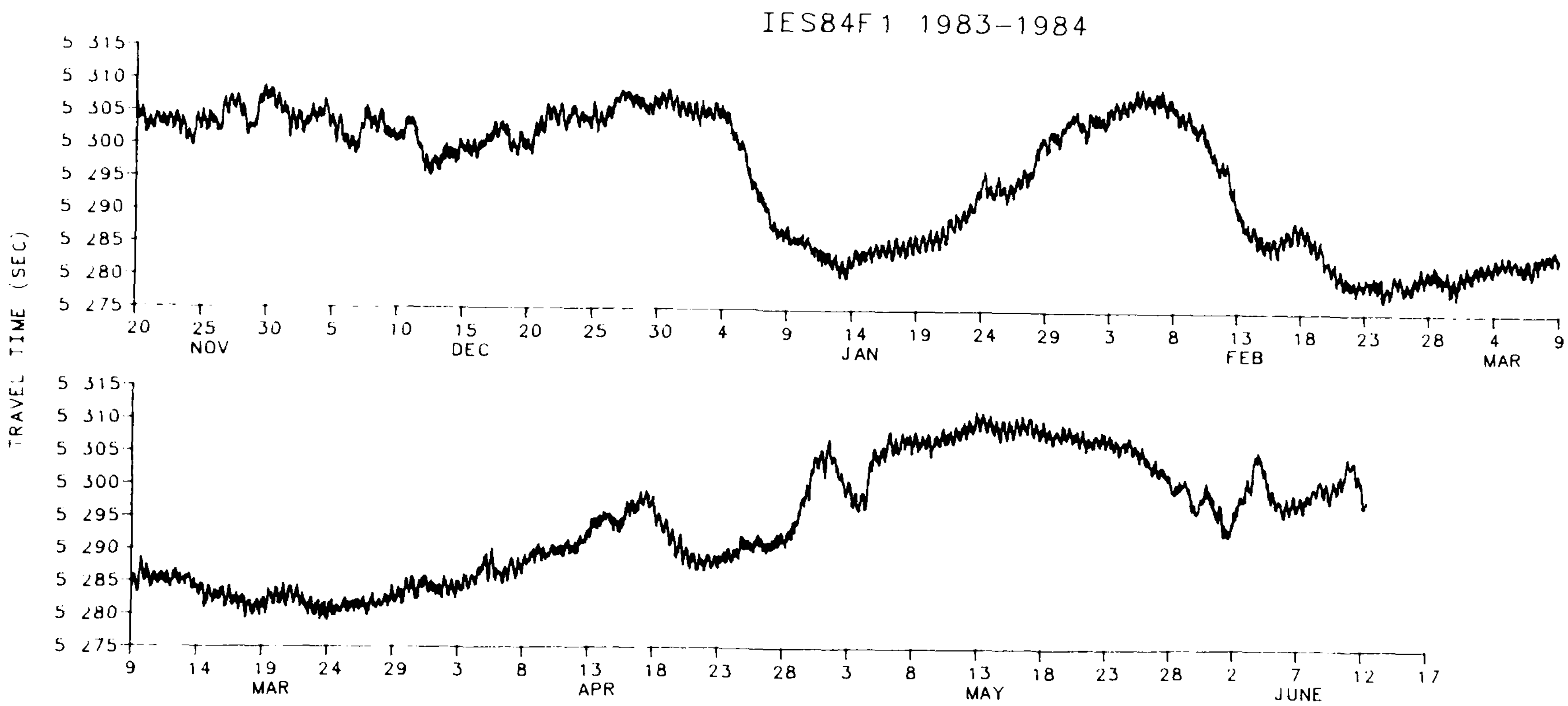


Figure 3.17 (continued)

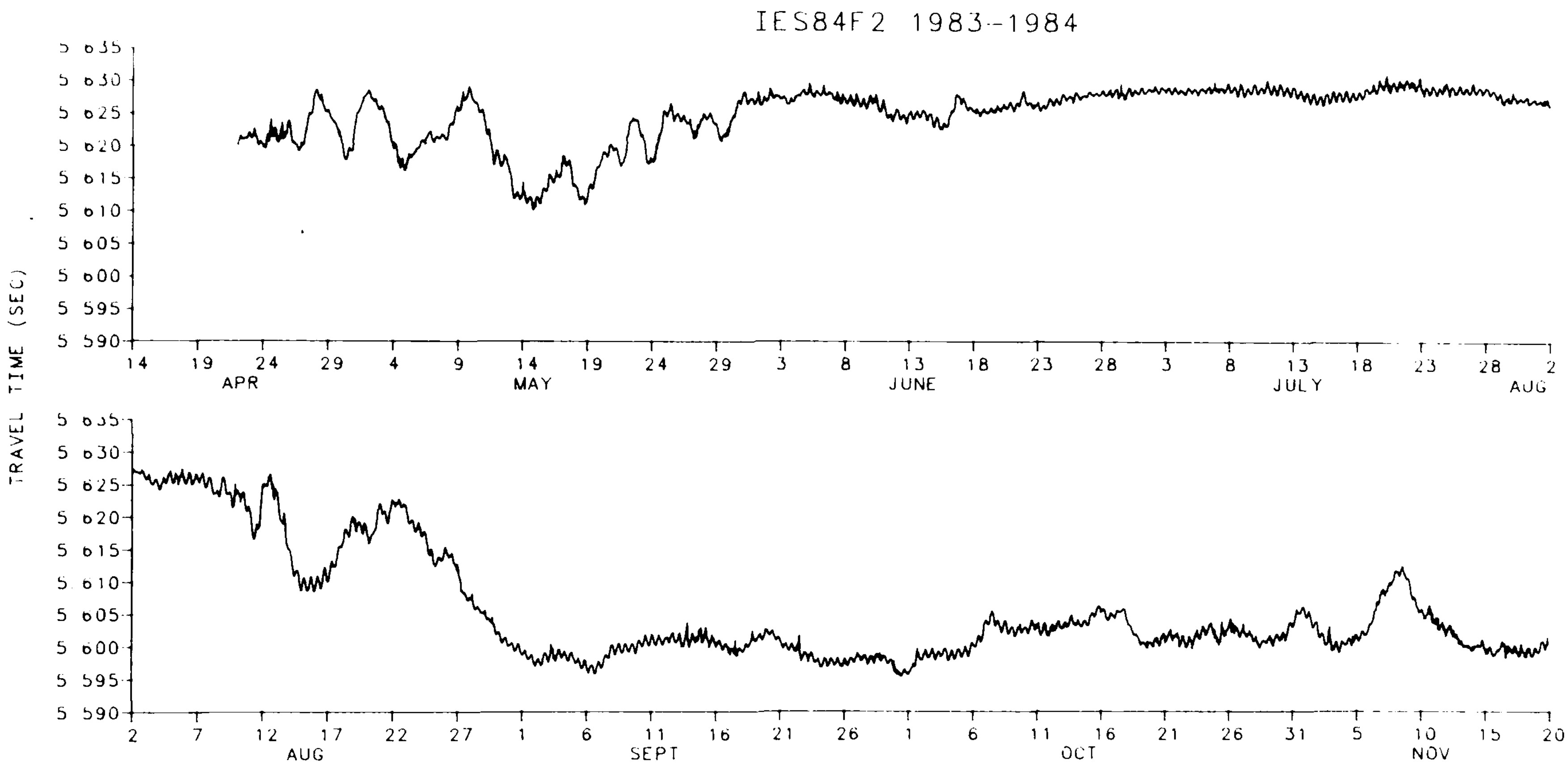

IES84F2 1983-1984
TRAVEL TIME (SEC)
5.635
5.630
5.625
5.620
5.615
5.610
5.605
5.600
5.595
5.590
14 19 24 29 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2
APR
MAY
JUNE
JULY
AUG
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG
SEPT
OCT
NOV

Figure 3.18

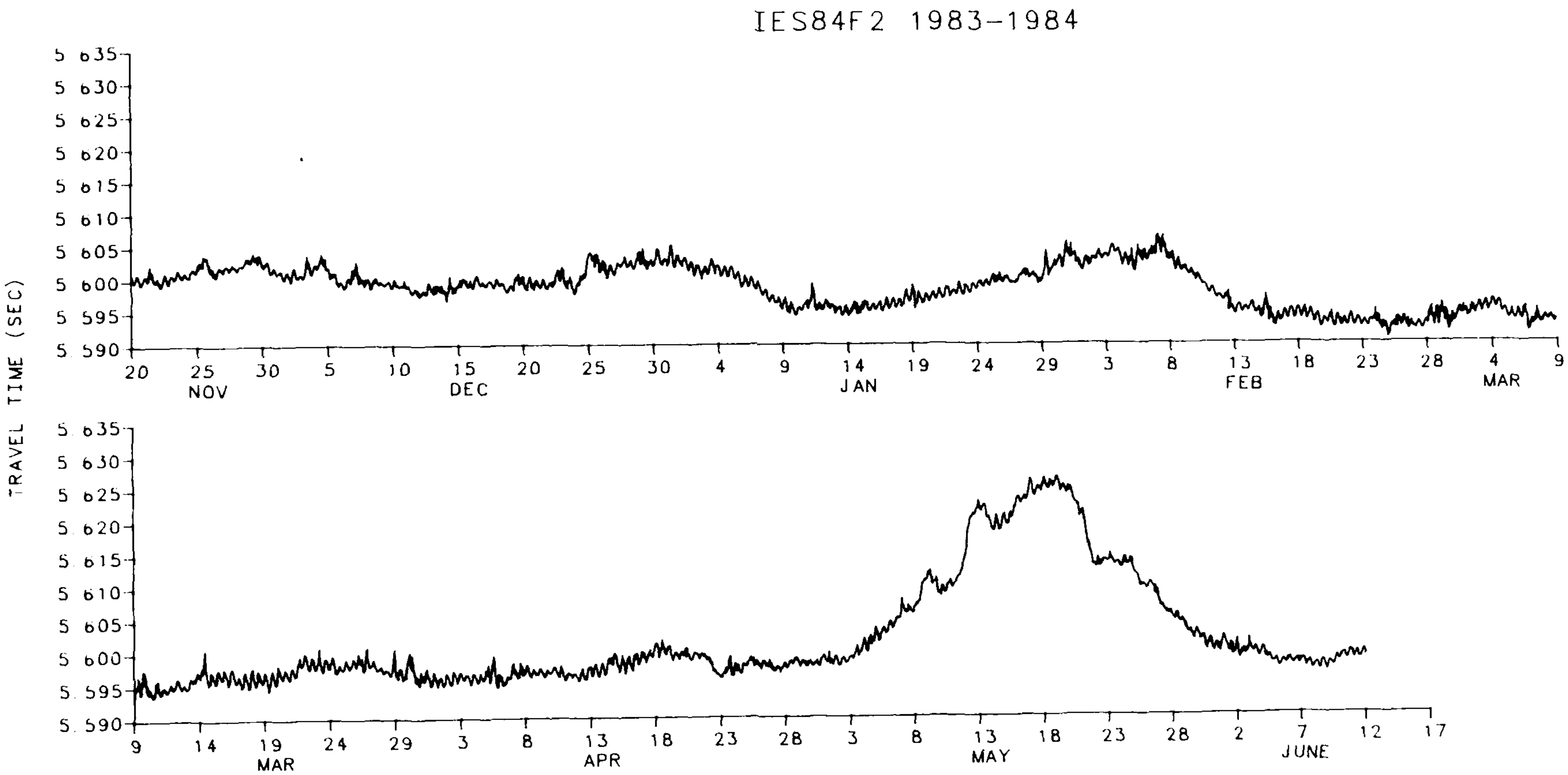


Figure 3.18 (continued)

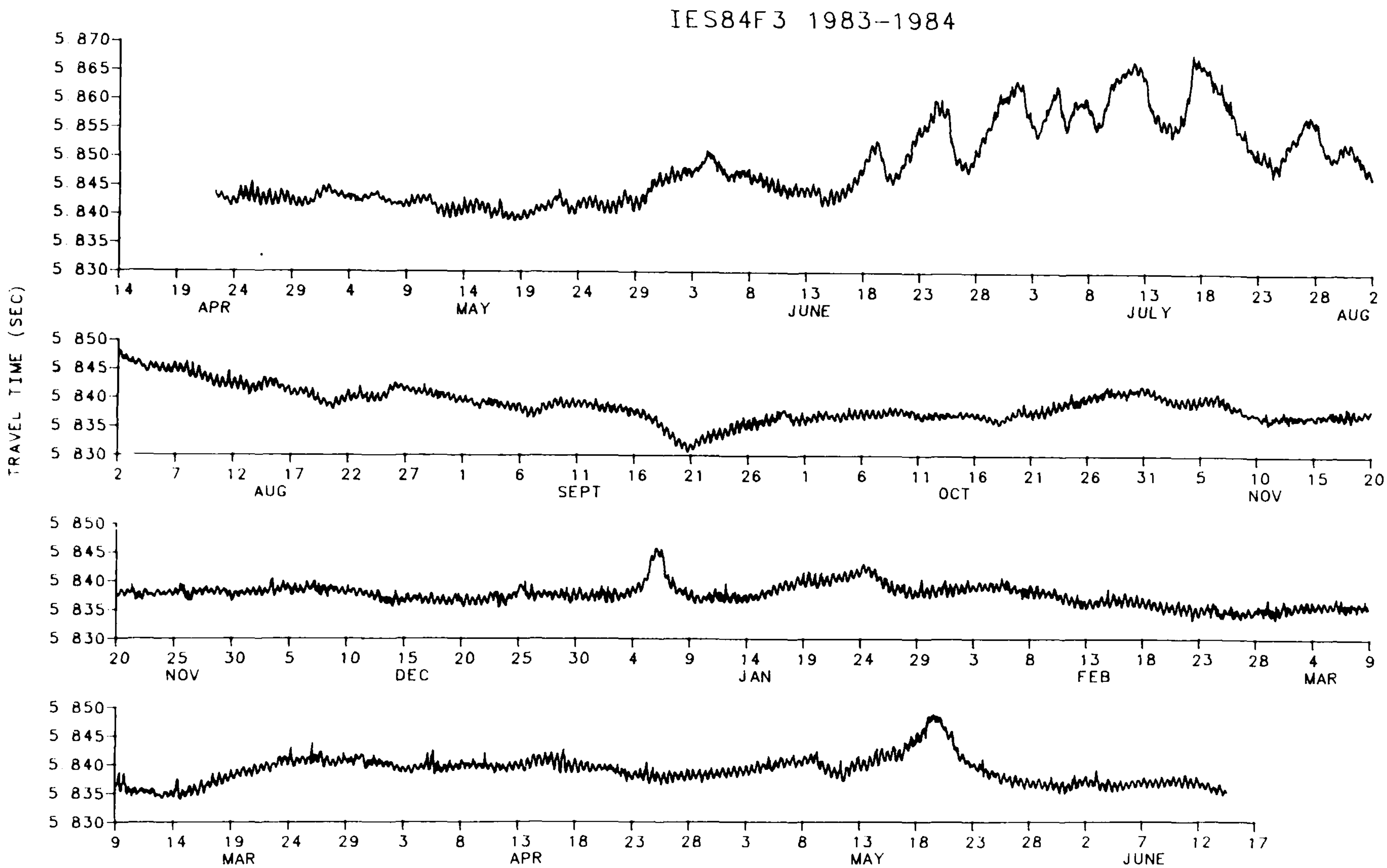

IES84F3 1983-1984
TRAVEL TIME (SEC)
5.870
5.865
5.860
5.855
5.850
5.845
5.840
5.835
5.830
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR

Figure 3.19

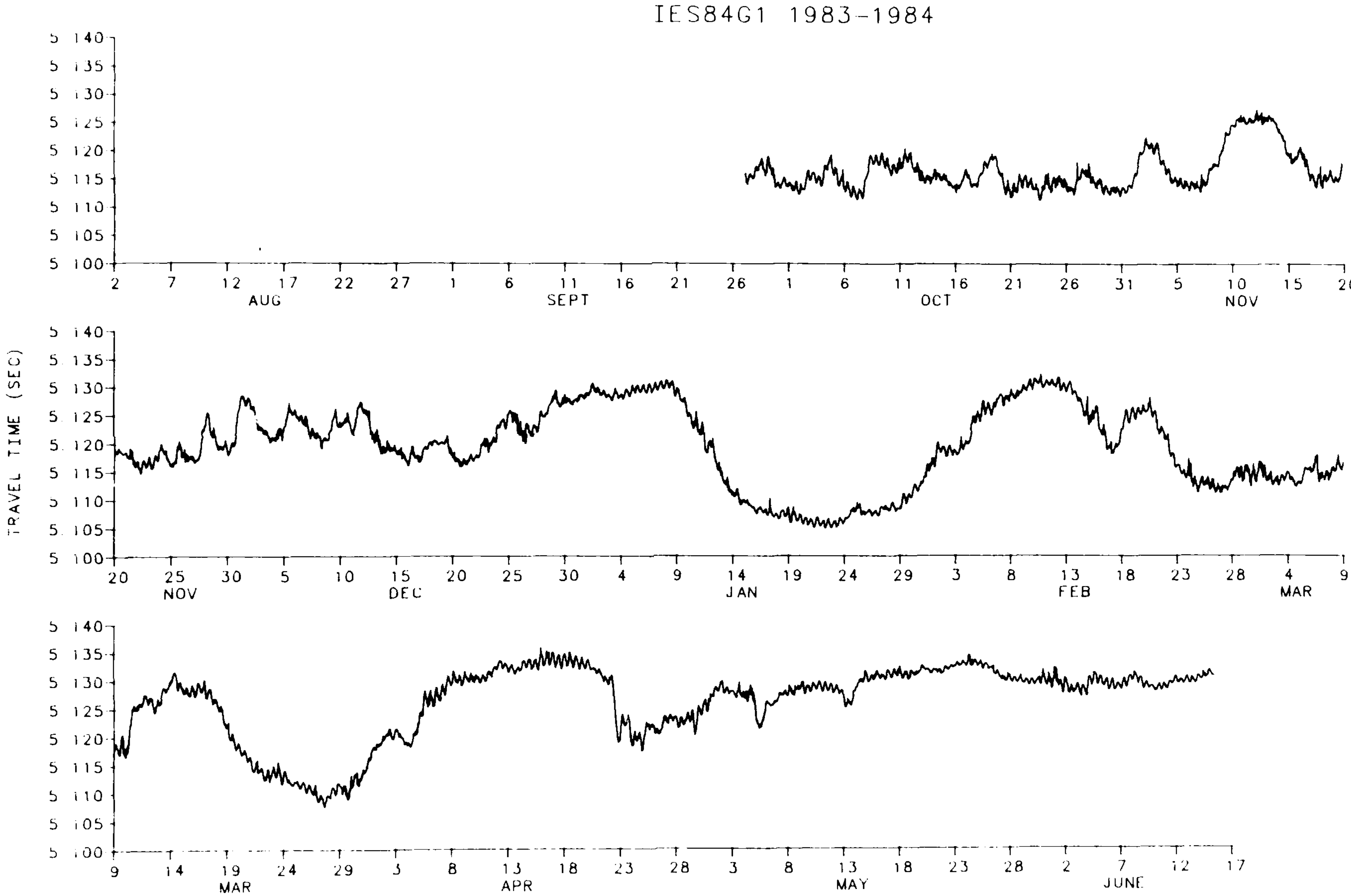

IES84G1 1983-1984
TRAVEL TIME (SEC)
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE

Figure 3.20

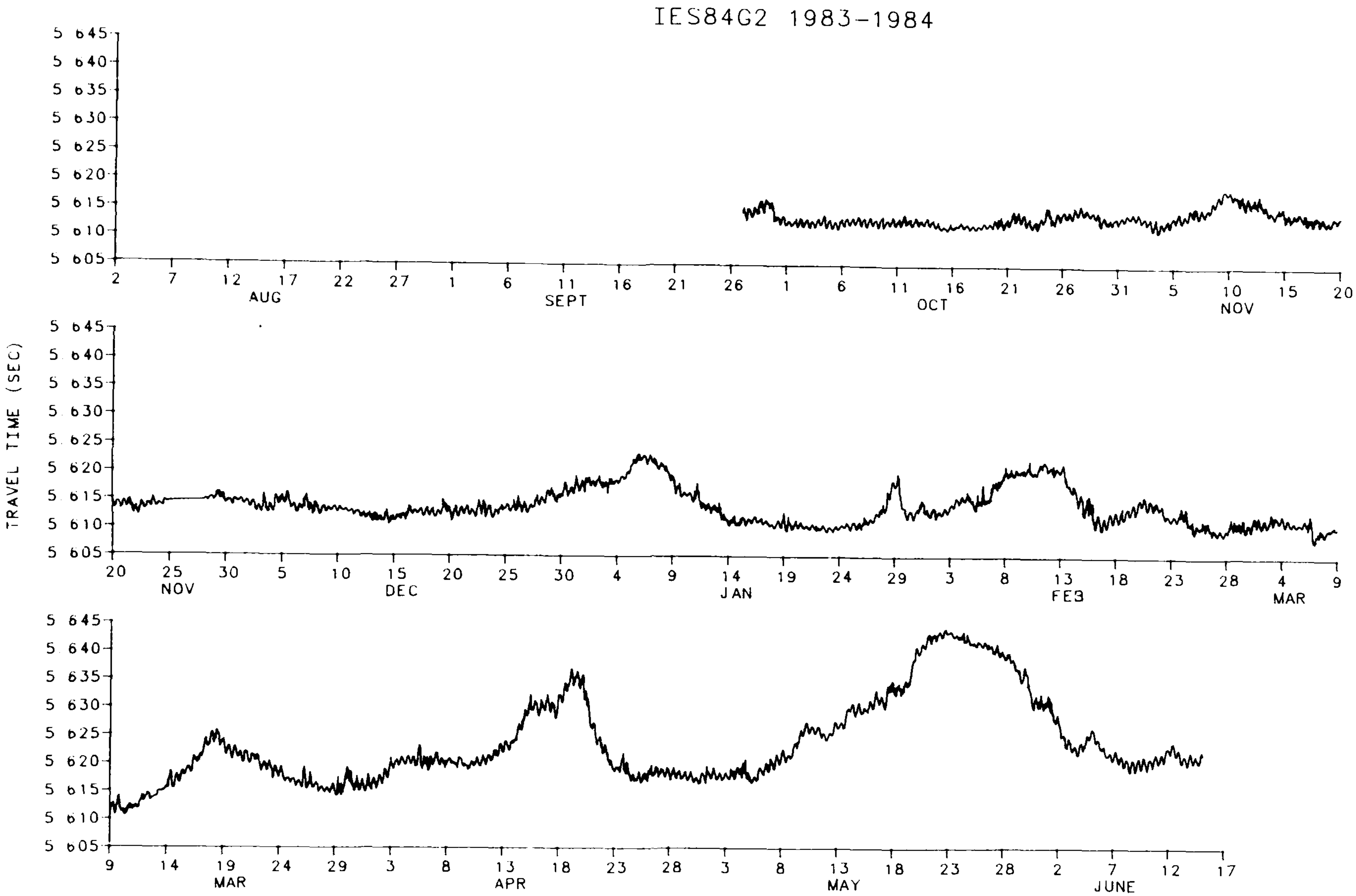

IES84G2 1983-1984
TRAVEL TIME (SEC)
5 645
5 640
5 635
5 630
5 625
5 620
5 615
5 610
5 605
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG
SEPT
OCT
NOV
20 25 30 5 10 15 20 25 30 4 9 14 19 24 29 3 8 13 18 23 28 4 9
NOV
DEC
JAN
FEB
MAR
9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2 7 12 17
MAR
APR
MAY
JUNE

Figure 3.21

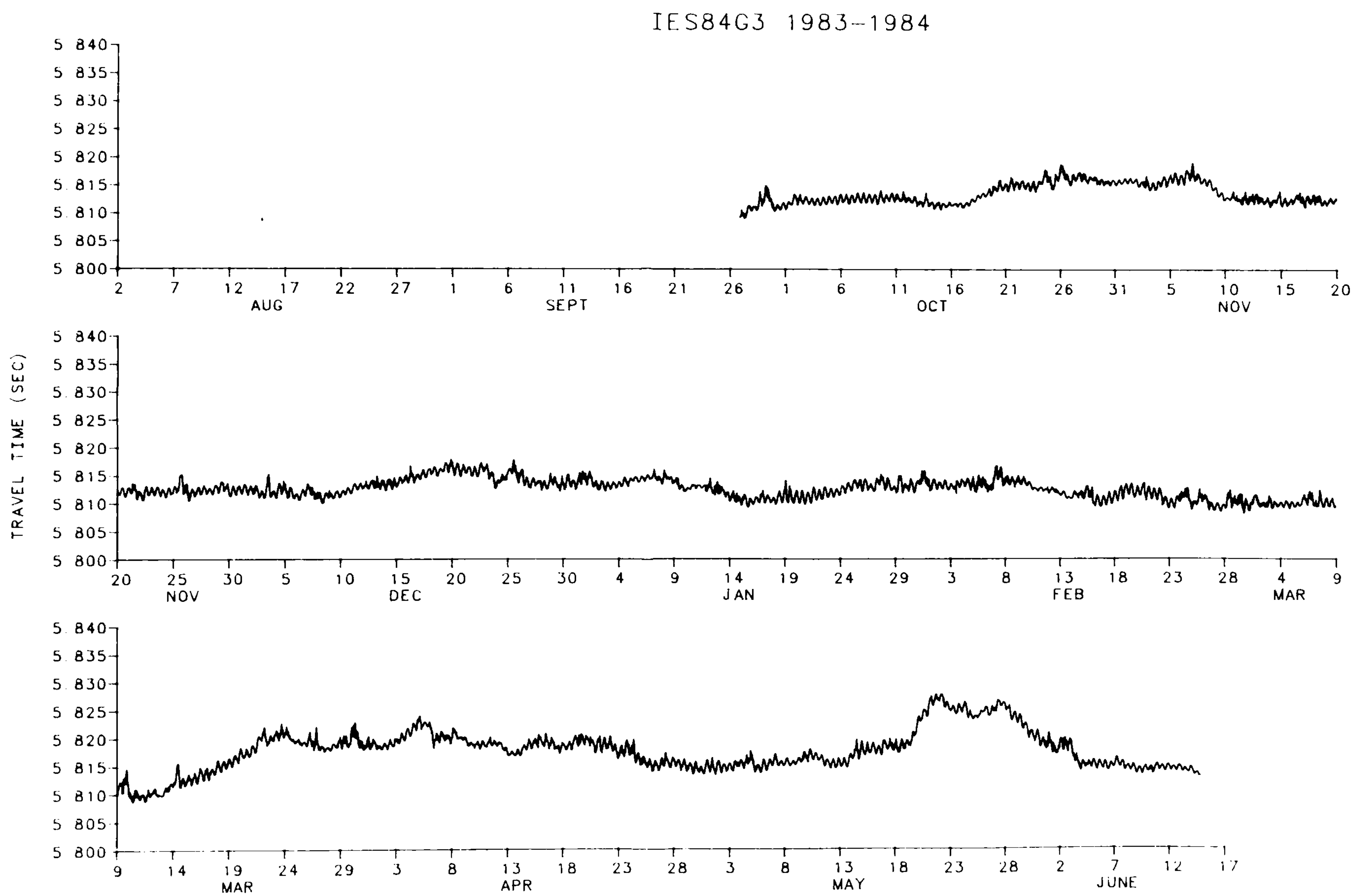

IES84G3 1983–1984
TRAVEL TIME (SEC)
5 840
5 835
5 830
5 825
5 820
5 815
5 810
5 805
5 800
2 7 12 17 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20
AUG
SEPT
OCT
NOV
20 25 30 5 10 15 20 25 30 4 9 14 19 24 29 3 8 13 18 23 28 4 9
NOV
DEC
JAN
FEB
MAR
9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2 7 12 17
MAR
APR
MAY
JUNE

Figure 3.22

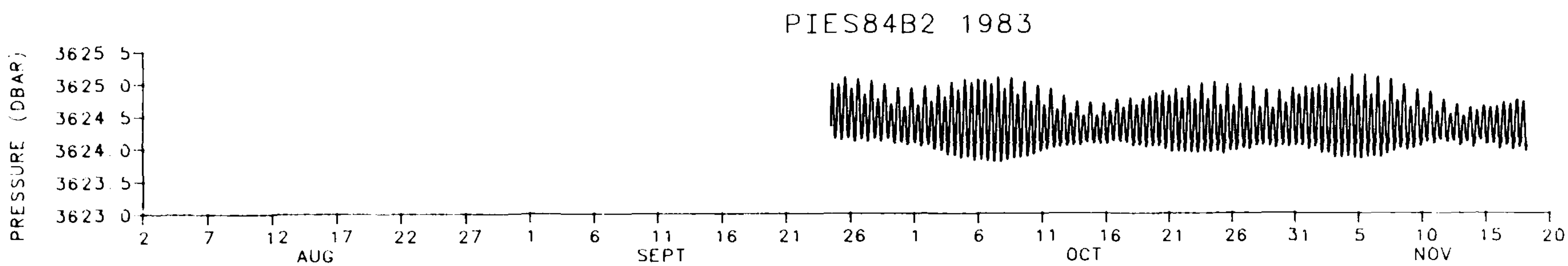
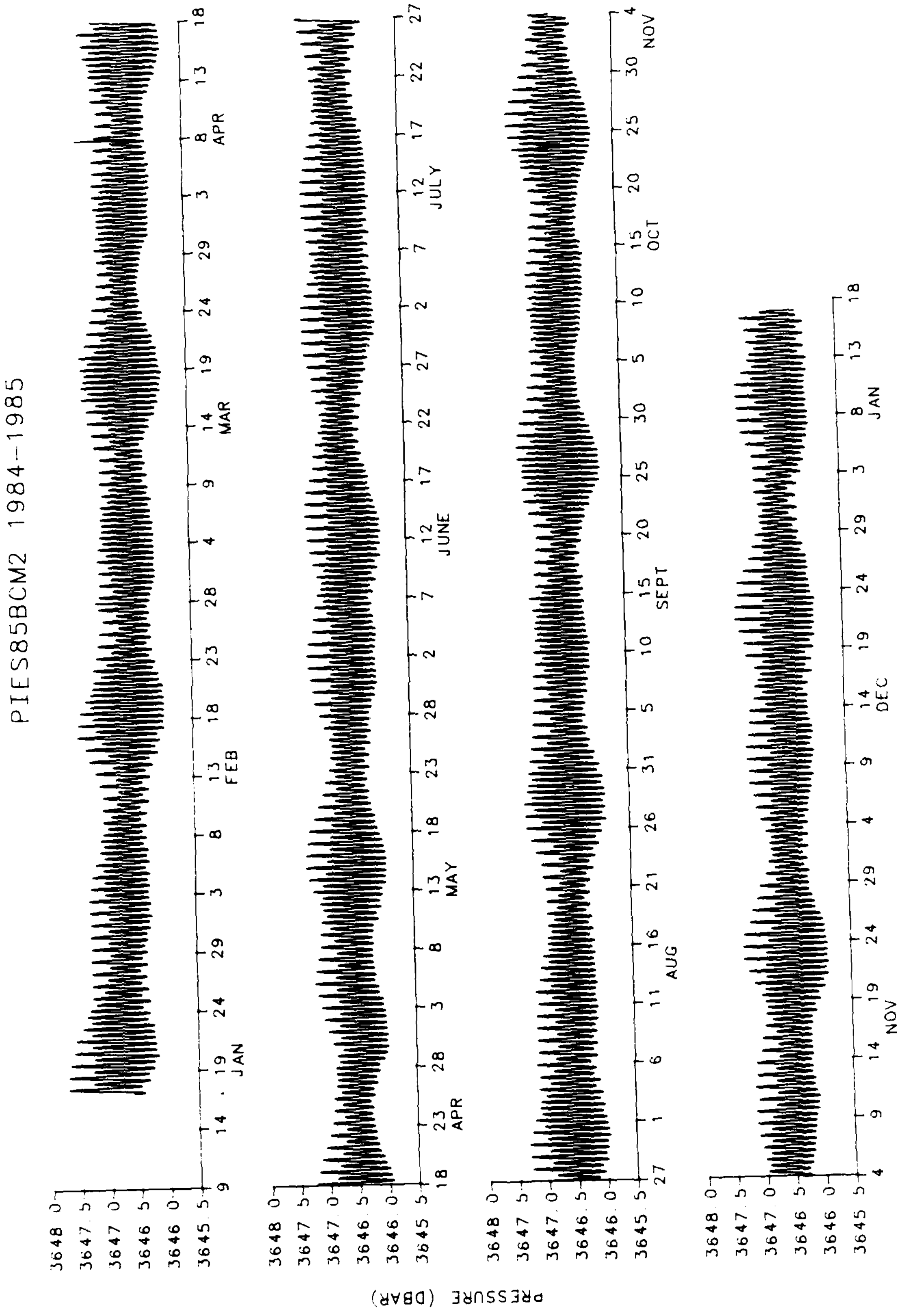


Figure 4.1

Figure 4.1-5. Full measured bottom pressure records at half-hourly intervals.



PIES85BCM2 1984-1985
PRESSURE (DBAR)
3648.0
3647.5
3647.0
3646.5
3646.0
3645.5
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC

Figure 4.2

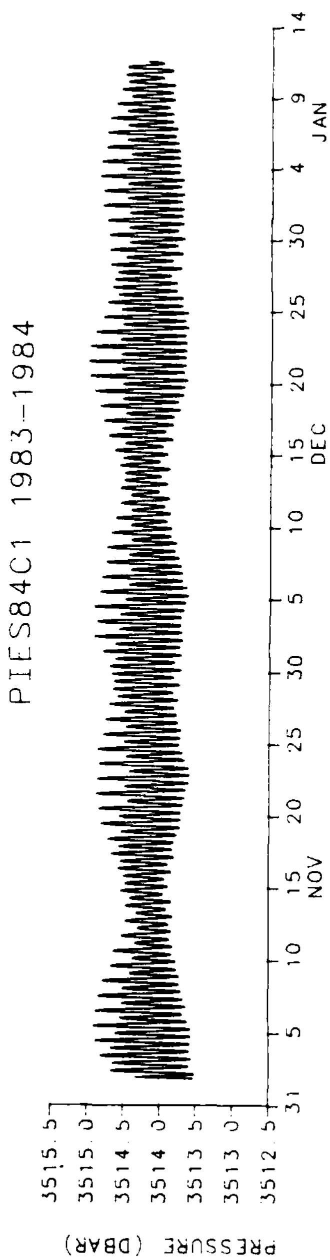

PIES84C1 1983-1984
PRESSURE (DBAR)
3515.5
3515.0
3514.5
3514.0
3513.5
3513.0
3512.5
31
5
10
15
NOV
20
25
30
5
10
15
DEC
20
25
30
4
9
JAN
14

Figure 4.3

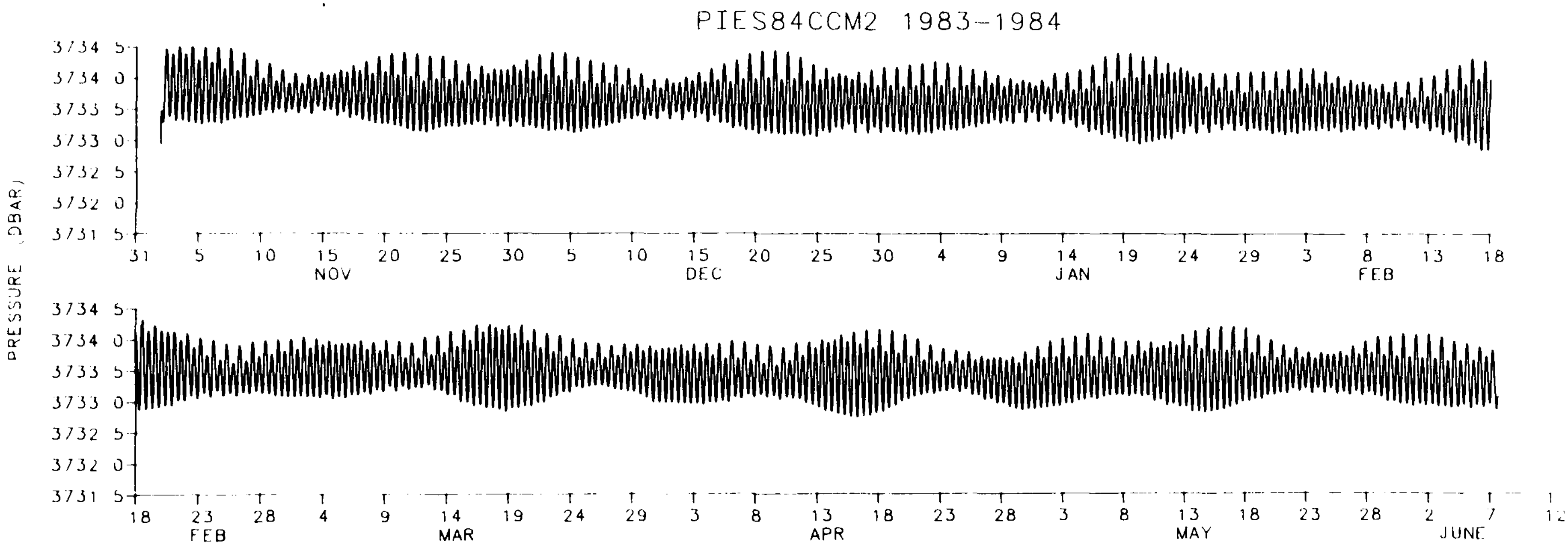

PIES84CCM2 1983-1984
PRESSURE (DBAR)
3734 5
3734 0
3733 5
3733 0
3732 5
3732 0
3731 5
31 5 10 15 20 25 30 5 10 15 20 25 30 4 9 14 19 24 29 3 8 13 18
NOV
DEC
JAN
FEB
18 23 28 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2 7 12
FEB
MAR
APR
MAY
JUNE

Figure 4.4

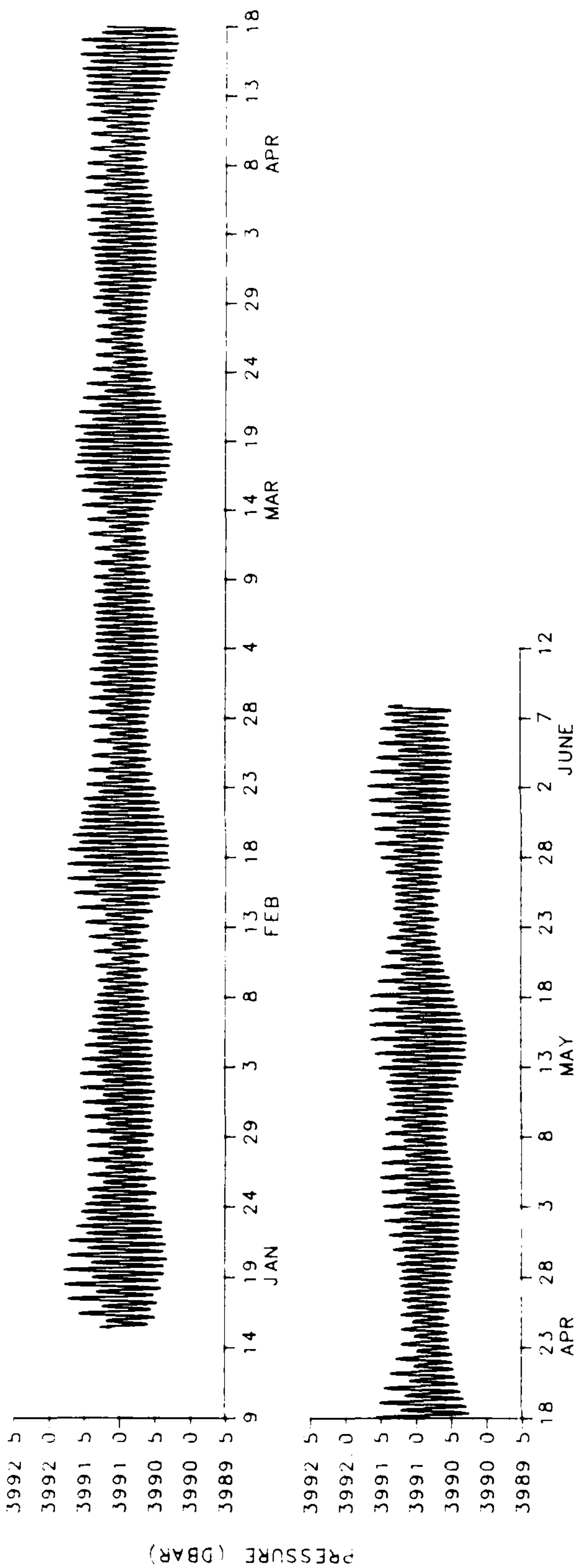

PIES84CCM3 1984
PRESSURE (DBAR)
3992.5
3992.0
3991.5
3991.0
3990.5
3990.0
3989.5
9
14
19
JAN
24
29
3
8
13
FEB
18
23
28
4
9
14
MAR
19
24
29
3
8
APR
13
18
18
23
APR
28
3
8
13
MAY
18
23
28
2
JUNE
7
12

Figure 4.5

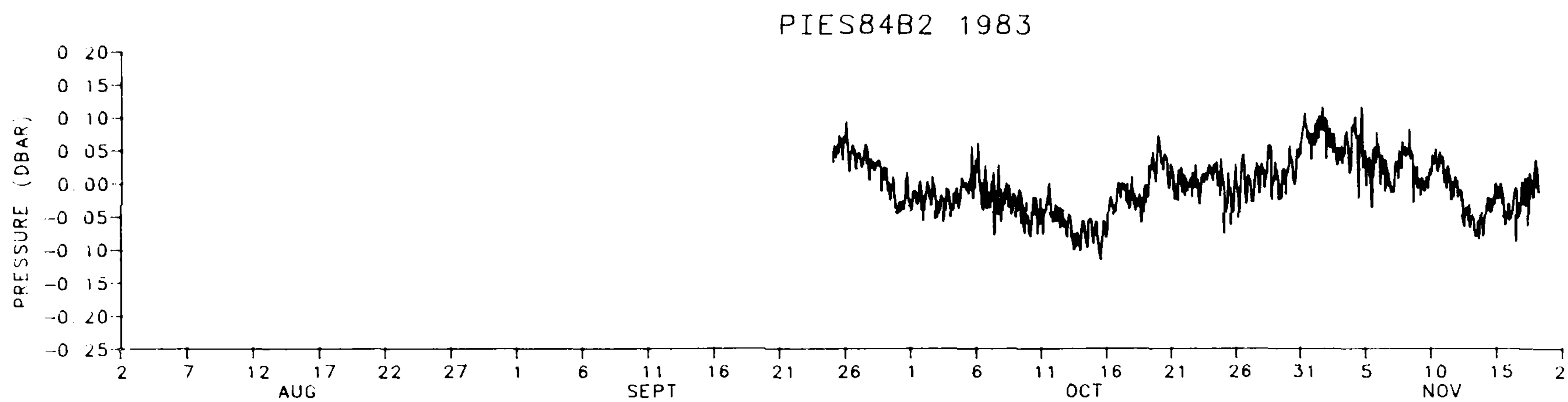
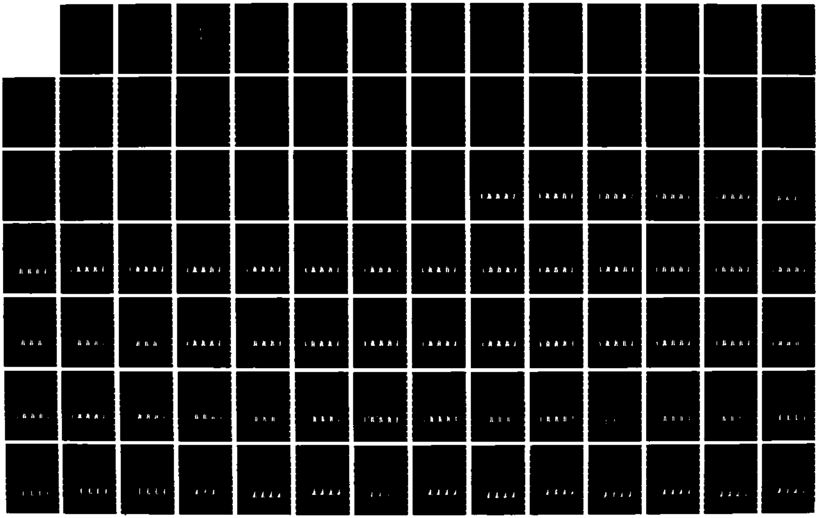


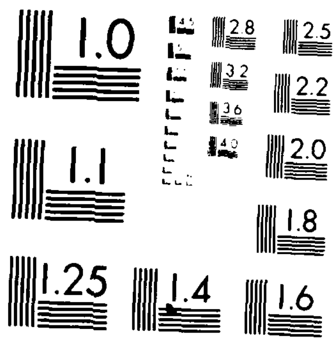
Figure 5.1

Figure 5.1-5. Residual bottom pressure records at half-hourly intervals. The tides, long-term drifts, and means, which have been removed, are given in Section 2.

AD-A170 757 THE GULF STREAM DYNAMICS EXPERIMENT INVERTED ECHO SOUNDER DATA REPORT FOR..(U) RHODE ISLAND UNIV KINGSTON GRADUATE SCHOOL OF OCEANOGRAPHY K L TRACEY ET AL. 2/3

UNCLASSIFIED APR 86 URI/GSO-TR-86-4 N00014-81-C-0062 F/G 8/10 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

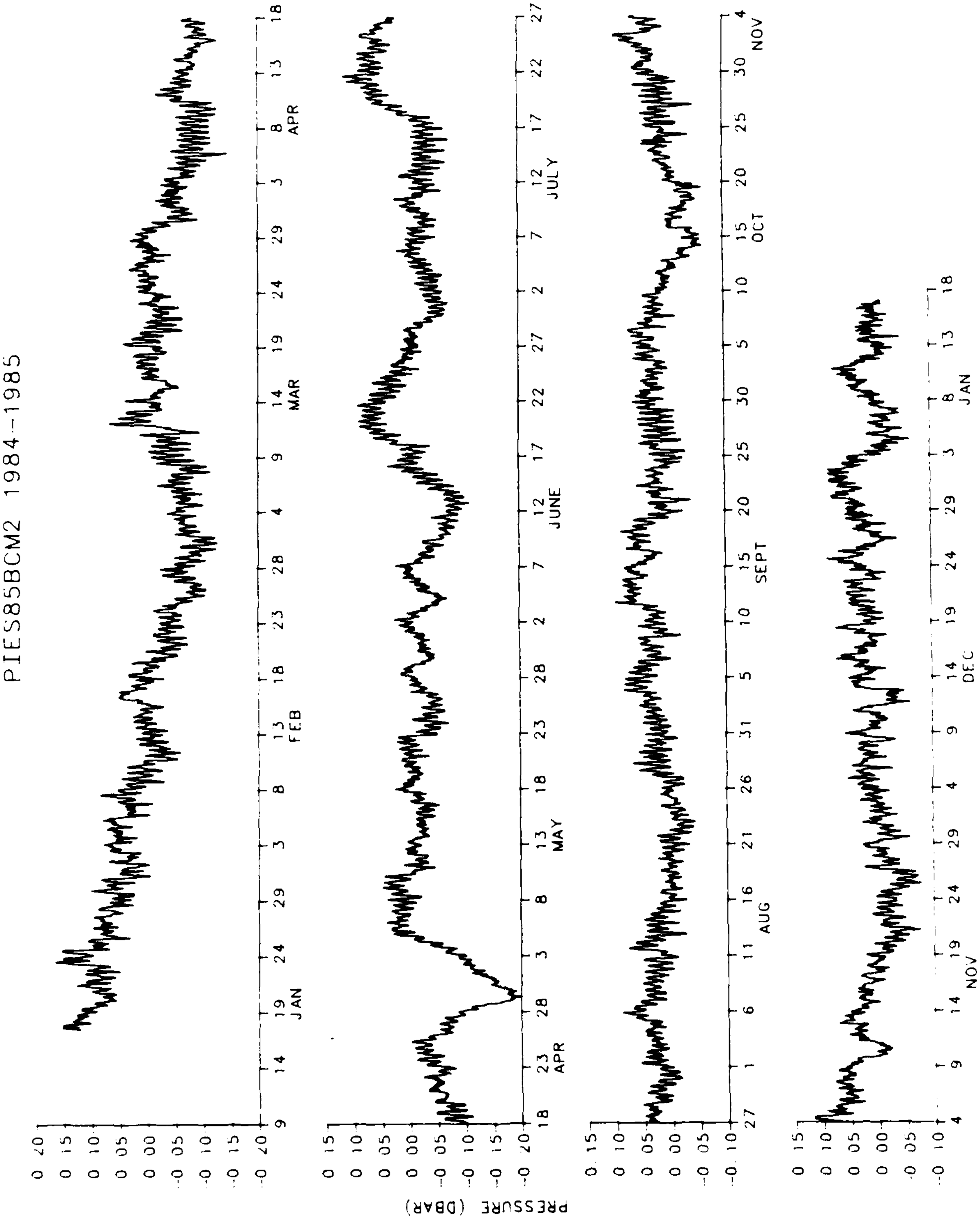

PIES85BCM2 1984-1985
PRESSURE (DBAR)
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN

Figure 5.2

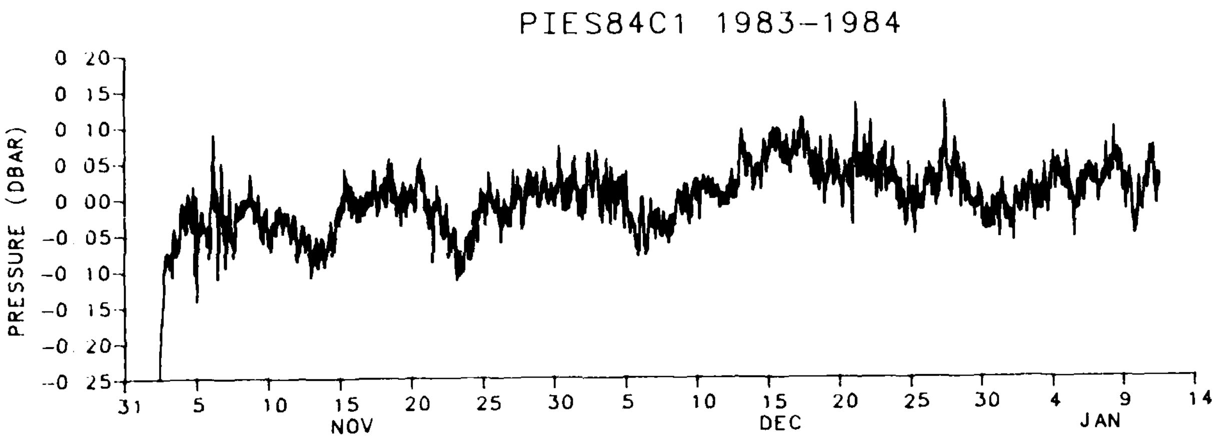

PIES84C1 1983-1984
PRESSURE (DBAR)
0 20
0 15
0 10
0 05
0 00
-0 05
-0 10
-0 15
-0 20
-0 25
31
5
10
15
20
25
30
5
10
15
20
25
30
4
9
14
NOV
DEC
JAN

Figure 5.3

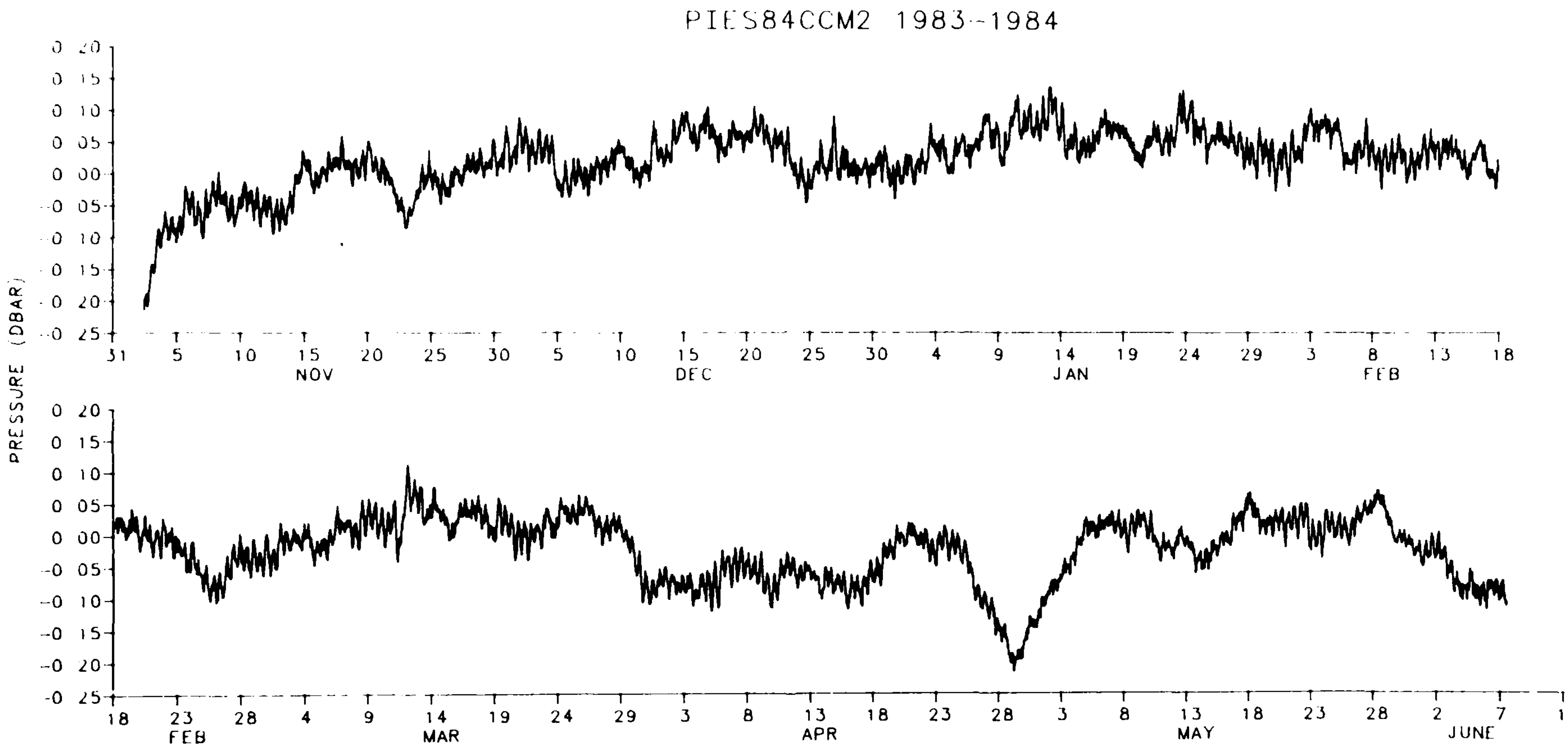

PIES84CCM2 1983-1984
PRESSURE (DBAR)
0 20
0 15
0 10
0 05
0 00
-0 05
-0 10
-0 15
-0 20
-0 25
31 5 10 15 20 25 30 5 10 15 20 25 30 4 9 14 19 24 29 3 8 13 18
NOV
DEC
JAN
FEB
18 23 28 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18 23 28 2 7 12
FEB
MAR
APR
MAY
JUNE

Figure 5.4

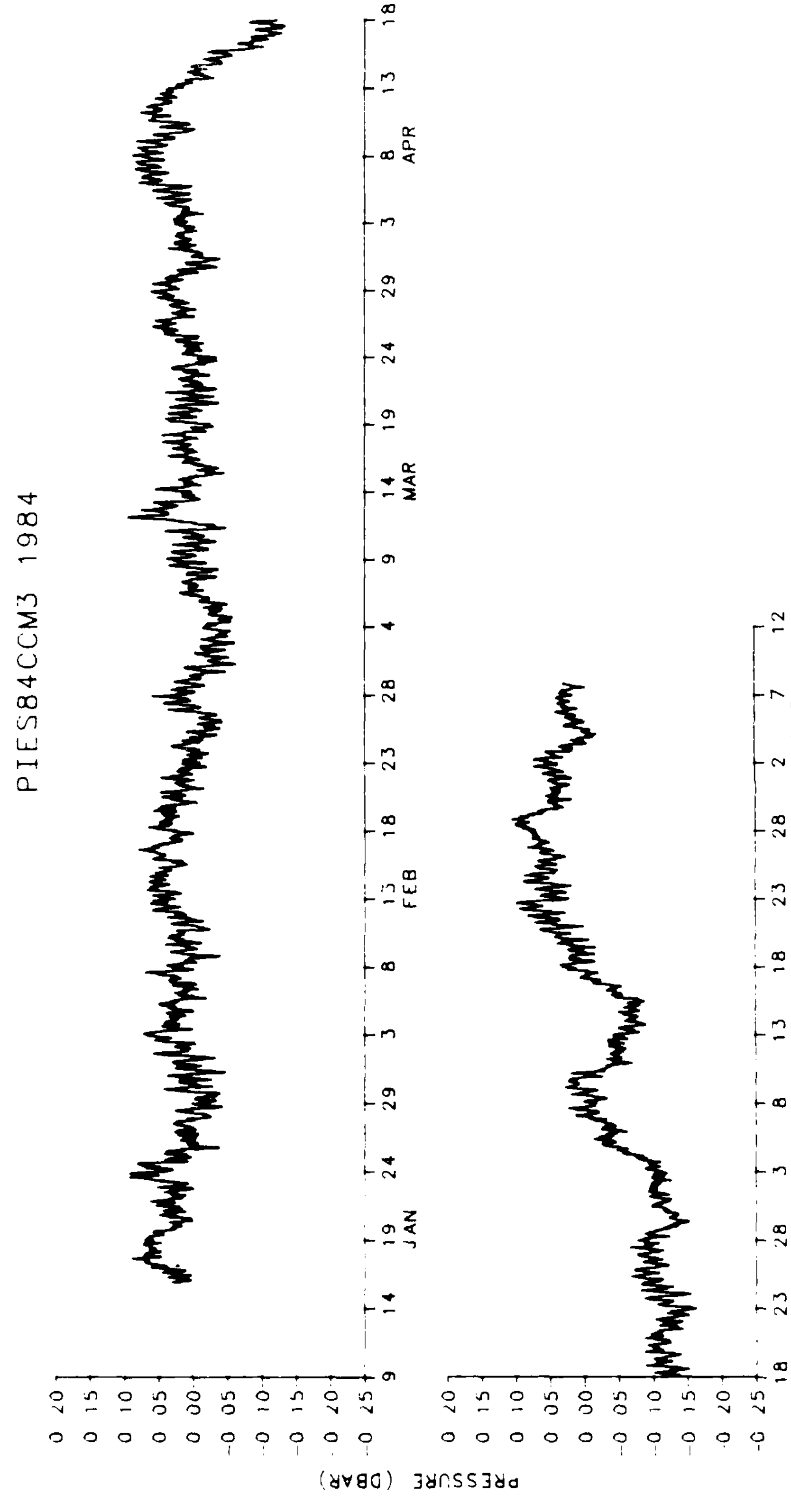

PIES84CCM3 1984
PRESSURE (DBAR)
0.20 0.15 0.10 0.05 0.00 -0.05 -0.10 -0.15 -0.20 -0.25
9 14 19 24 29 3 8 13 18 23 28 4 9 14 19 24 29 3 8 13 18
JAN FEB MAR APR
0.20 0.15 0.10 0.05 0.00 -0.05 -0.10 -0.15 -0.20 -0.25
18 23 28 3 8 13 18 23 28 2 7 12
APR MAY JUNE

Figure 5.5

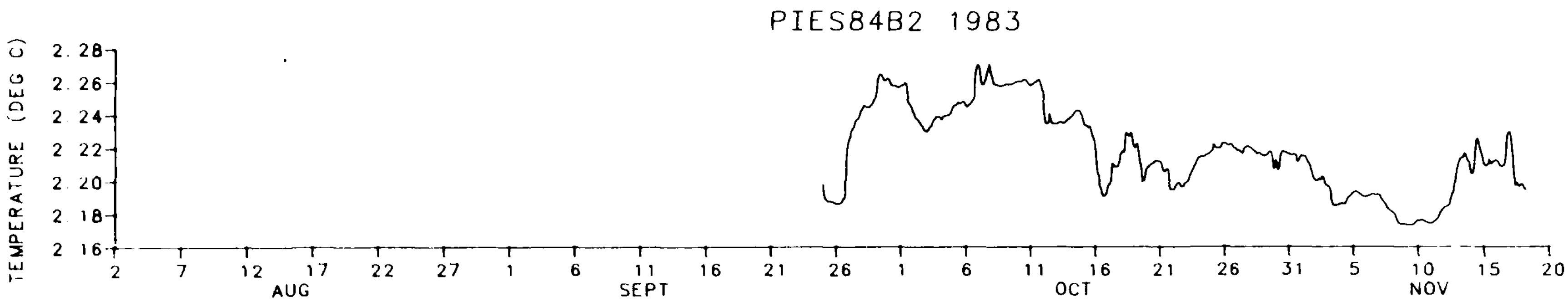


Figure 6.1

Figure 6.1-7 Full measured temperature records at half-hourly intervals.

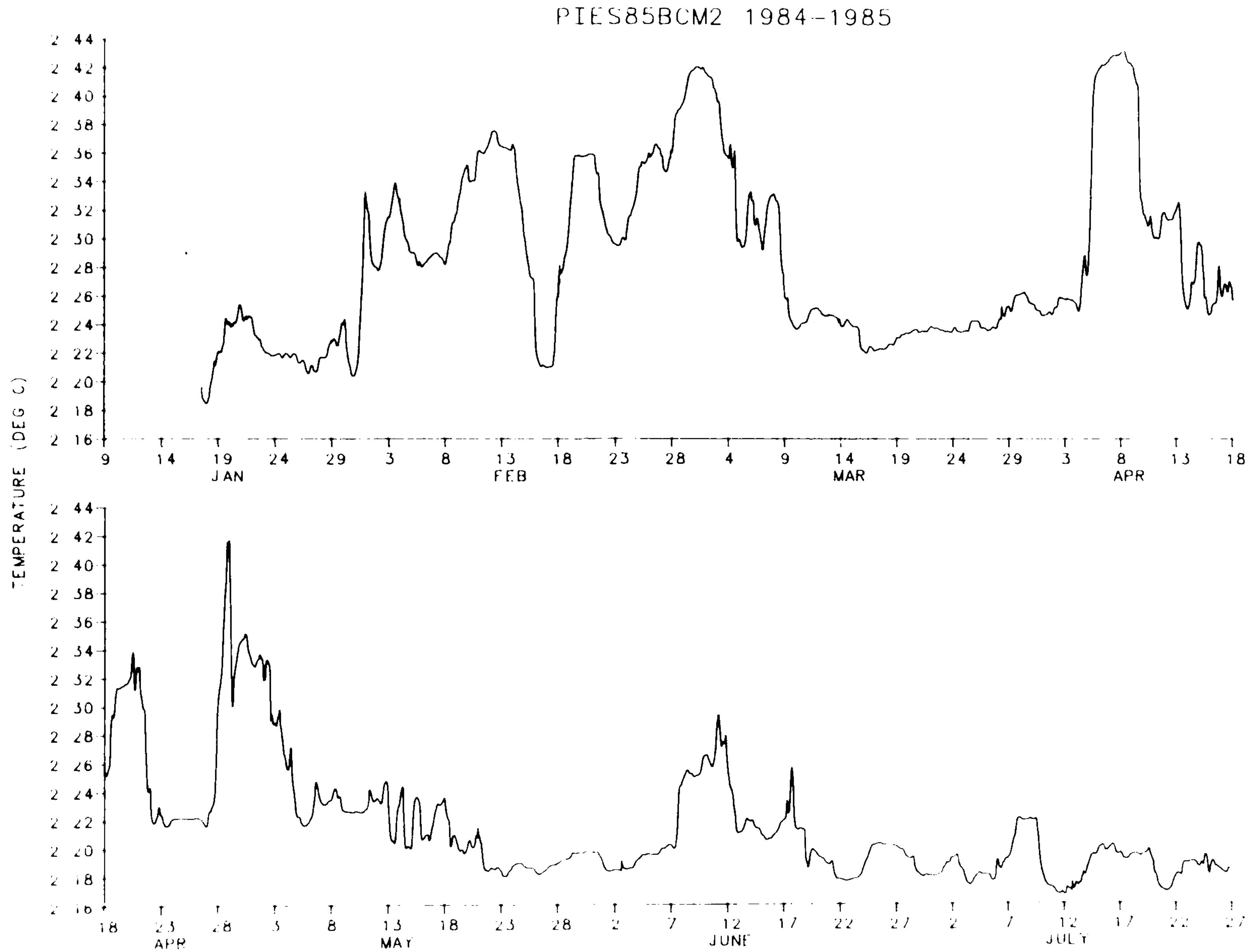

PIES85BCM2 1984-1985
TEMPERATURE (DEG C)
JAN
FEB
MAR
APR
MAY
JUNE
JULY

Figure 6.2

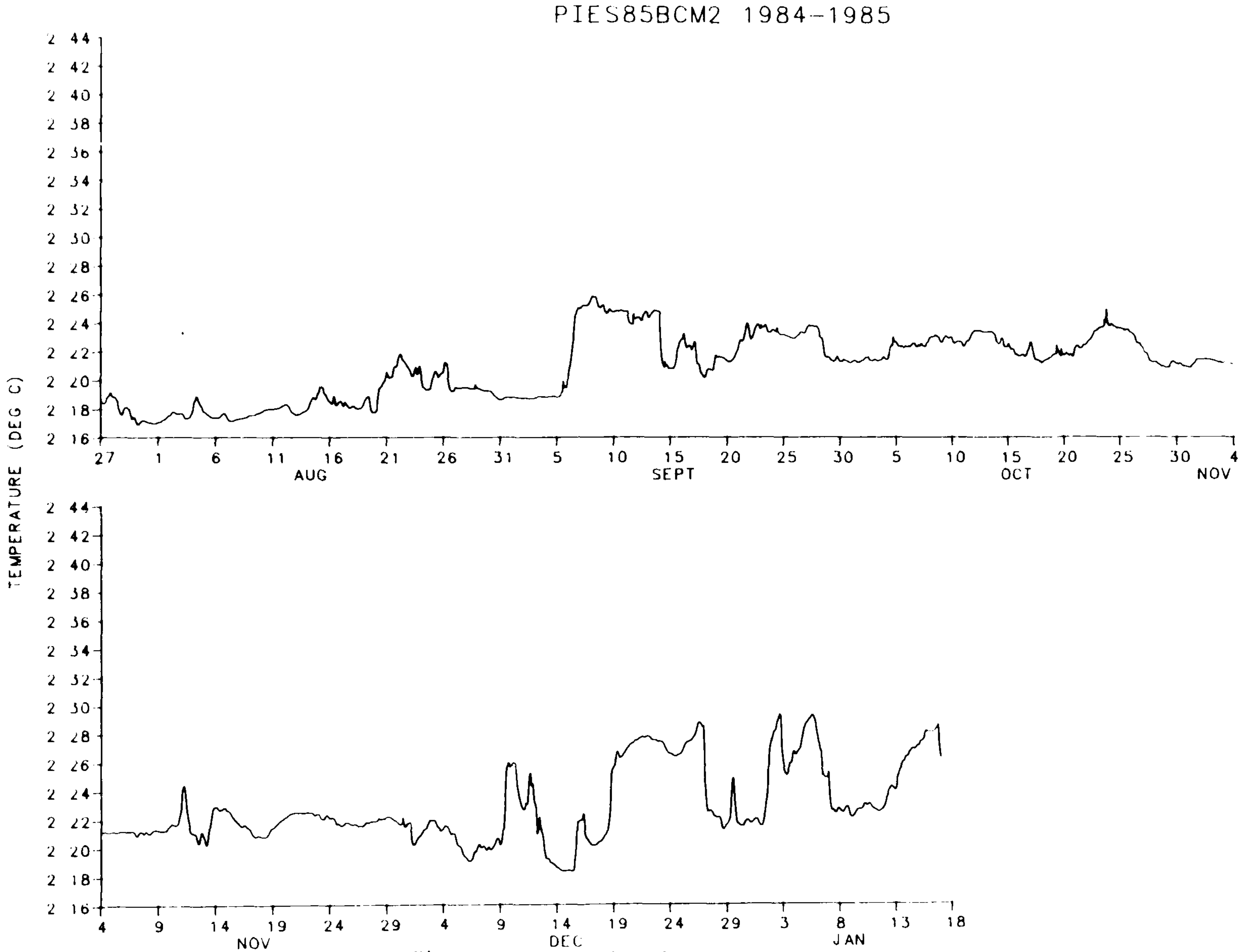


Figure 6.2 (continued)

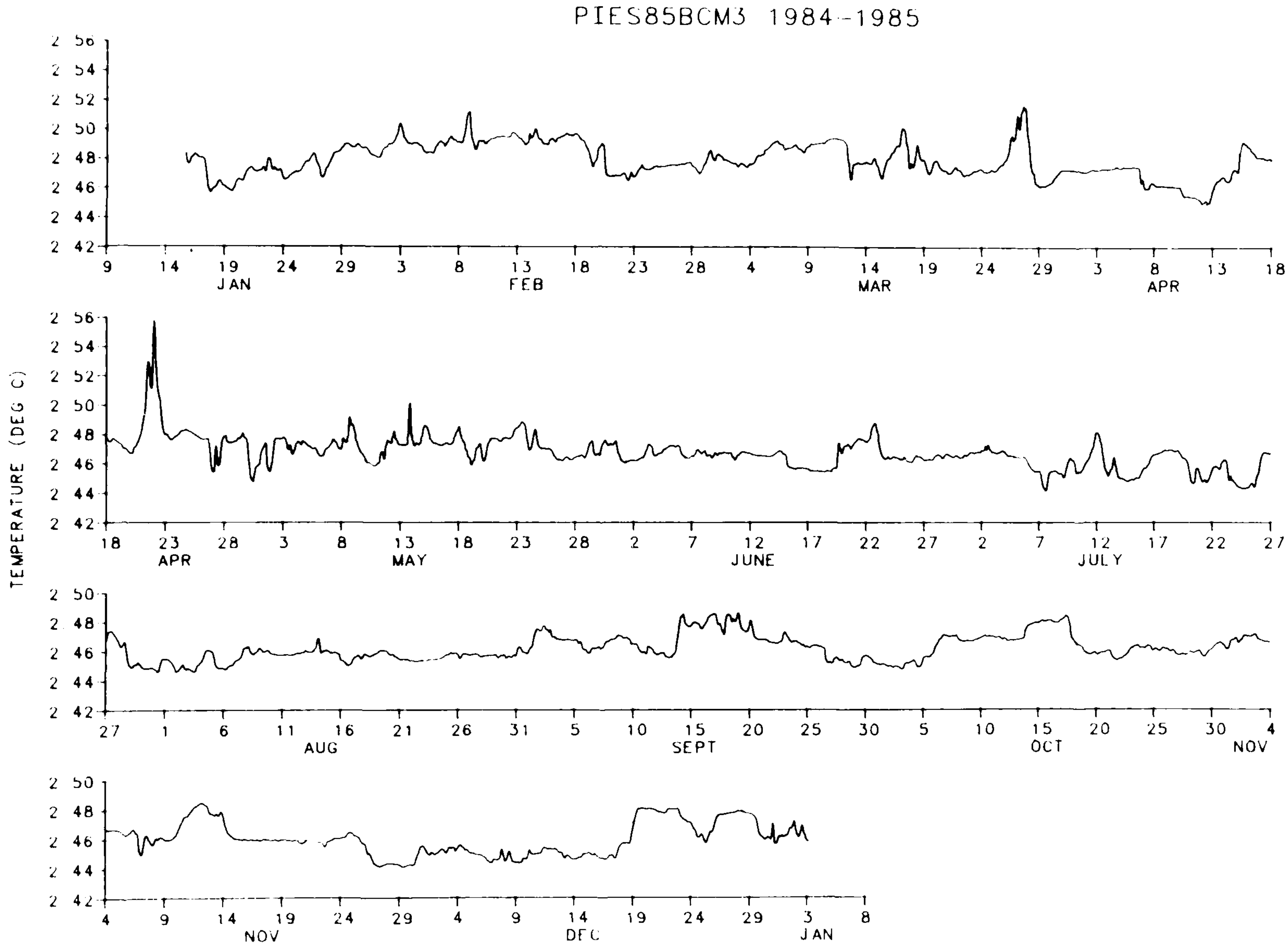

PIES85BCM3 1984-1985
TEMPERATURE (DEG C)
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN

Figure 6.3

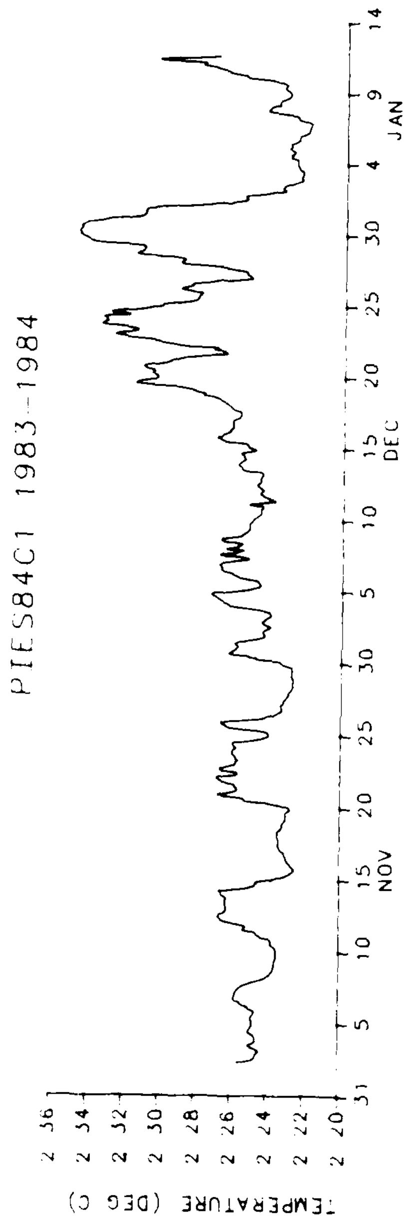

PIES84C1 1983-1984
TEMPERATURE (DEG C)
2.36
2.34
2.32
2.30
2.28
2.26
2.24
2.22
2.20
31
5
10
15
NOV
20
25
30
5
10
15
DEC
20
25
30
4
9
JAN
14

Figure 6.4

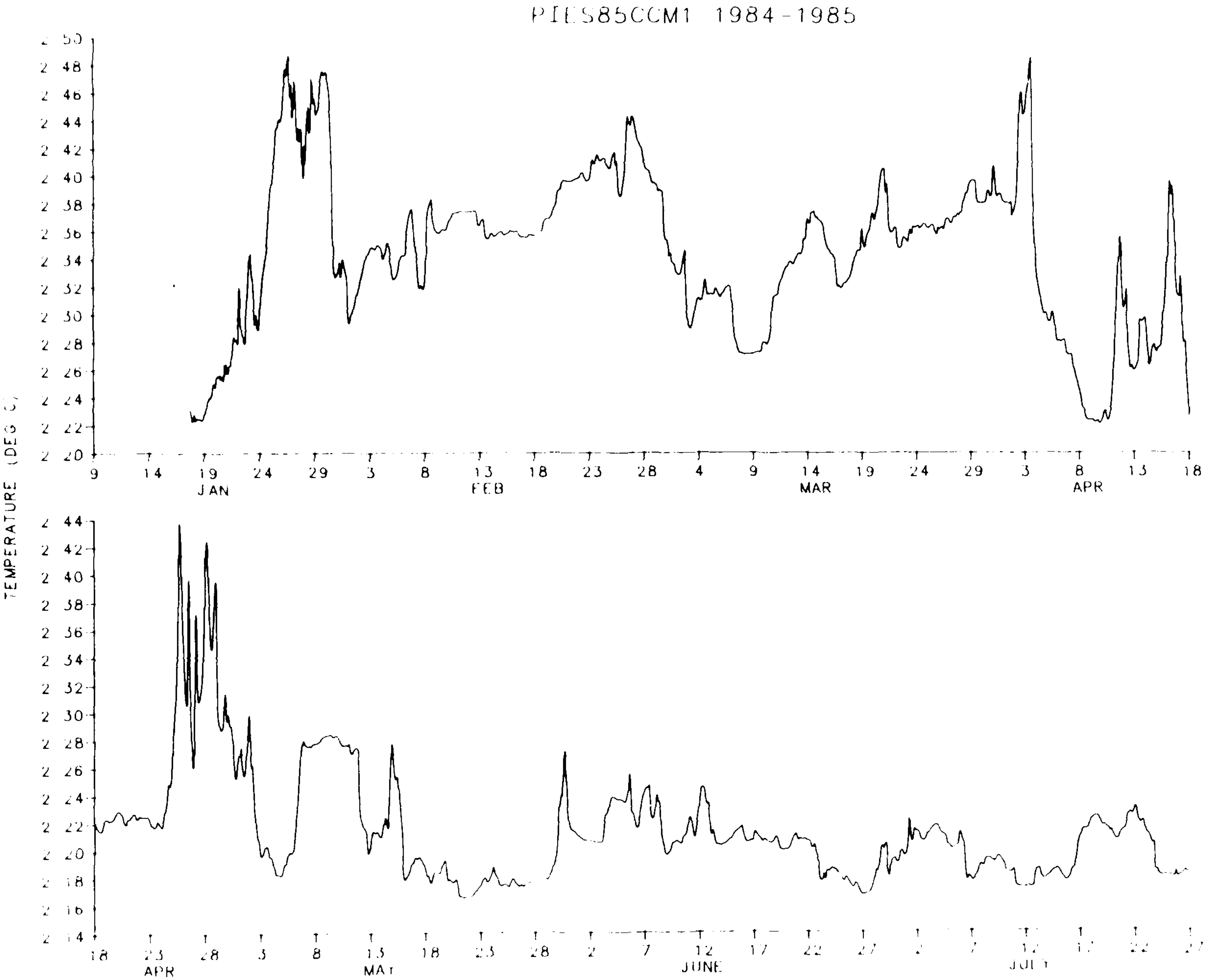

PIES85CCM1 1984-1985
TEMPERATURE (DEG C)
JAN
FEB
MAR
APR
APR
MAY
JUNE
JULY

Figure 6.5

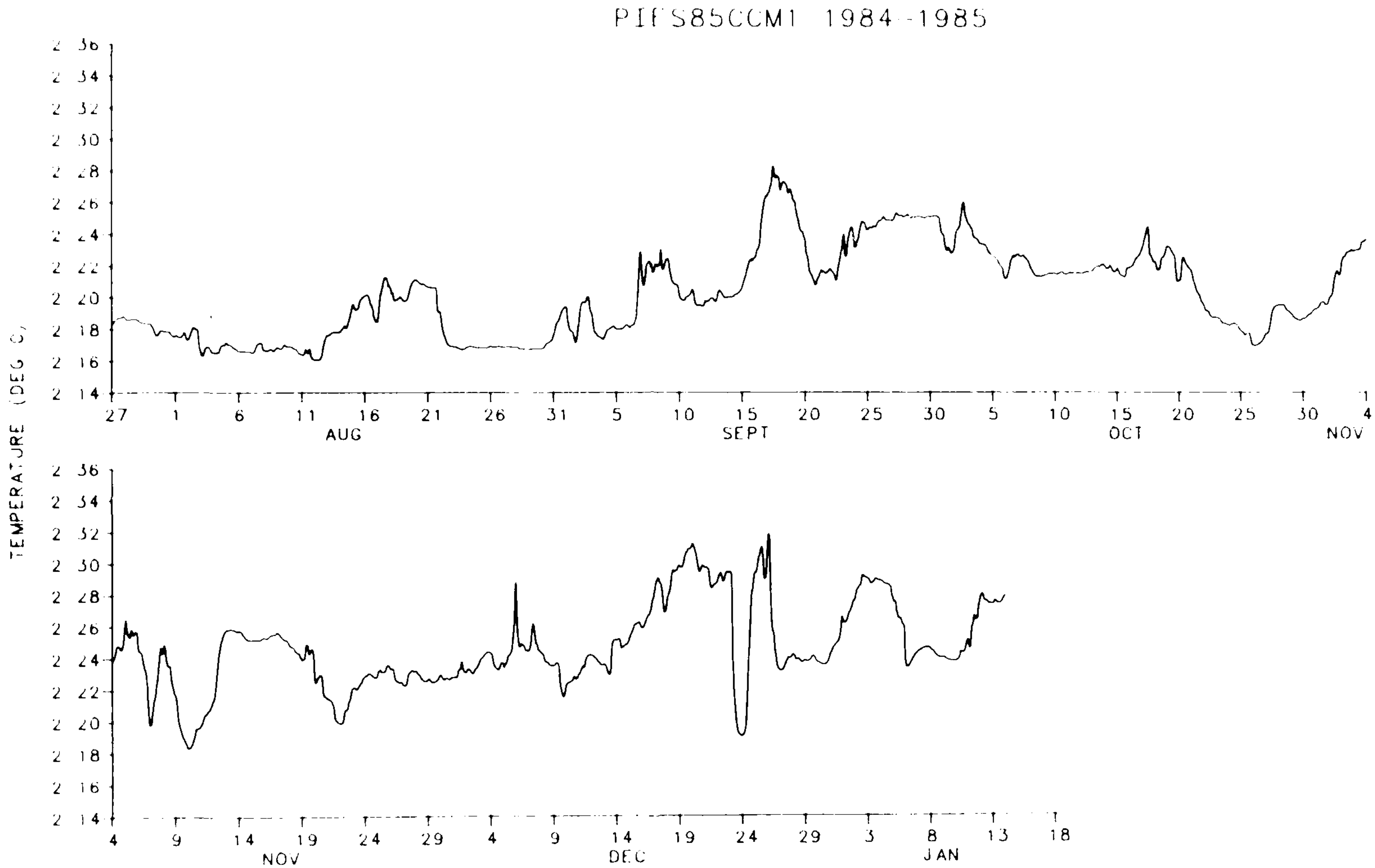


Figure 6.5 (continued)

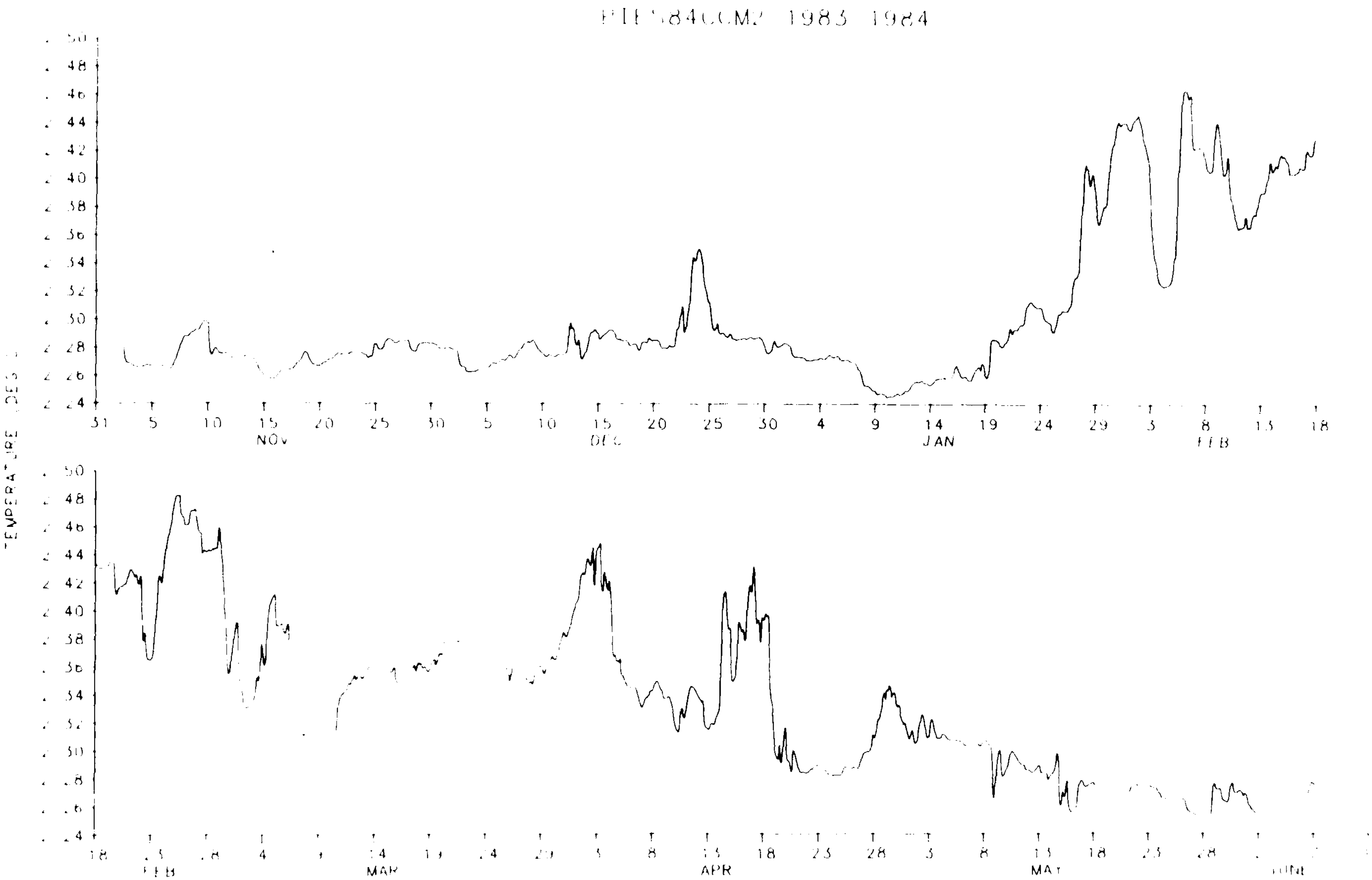


Figure 6.6

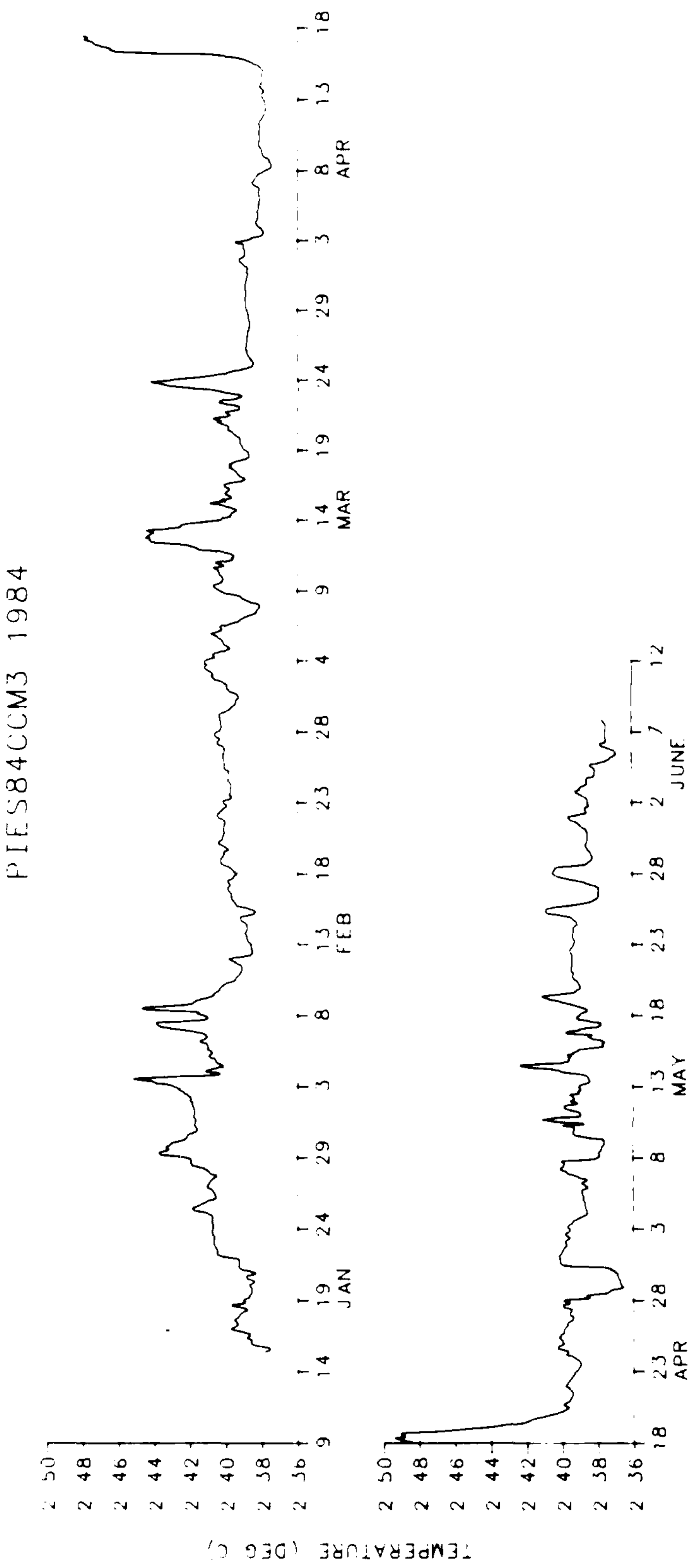

PIES84CCM3 1984
TEMPERATURE (DEG C)
2.50
2.48
2.46
2.44
2.42
2.40
2.38
2.36
9 14 19 24 29 3 8 13 18 23 28 4 9 14 19 24 29 3 8 13 18
JAN FEB MAR APR
18 23 28 3 8 13 18 23 28 2 7 12
APR MAY JUNE

Figure 6.7

SECTION 4

40 HRLP Data For Each Cross-Stream Section

The 40 HRLP thermocline depth (Z_{12}), bottom pressure, and temperature records are presented for each instrument. These are grouped by cross-stream line, with the northernmost IES on each line plotted at the top. Each record is labelled with the instrument name in the upper left corner.

The 40 HRLP Z_{12} records for each cross-stream section are presented first. These are followed by the 40 HRLP residual pressure records and the 40 HRLP temperature data for the instruments which had those additional sensors.

The time scale is the same for all plots, with each increment corresponding to 10 days. The axis begins on 0000 GMT of the first date labelled.

Vertical scale for each variable is consistent between instruments. Each increment corresponds to 100 m for the Z_{12} records, 0.05 dbar for the bottom pressure measurements, and 0.04°C for the temperatures.

The sampling interval is 6 hours for all variables. The length and the start and end times of the data records are tabulated in Section 2.

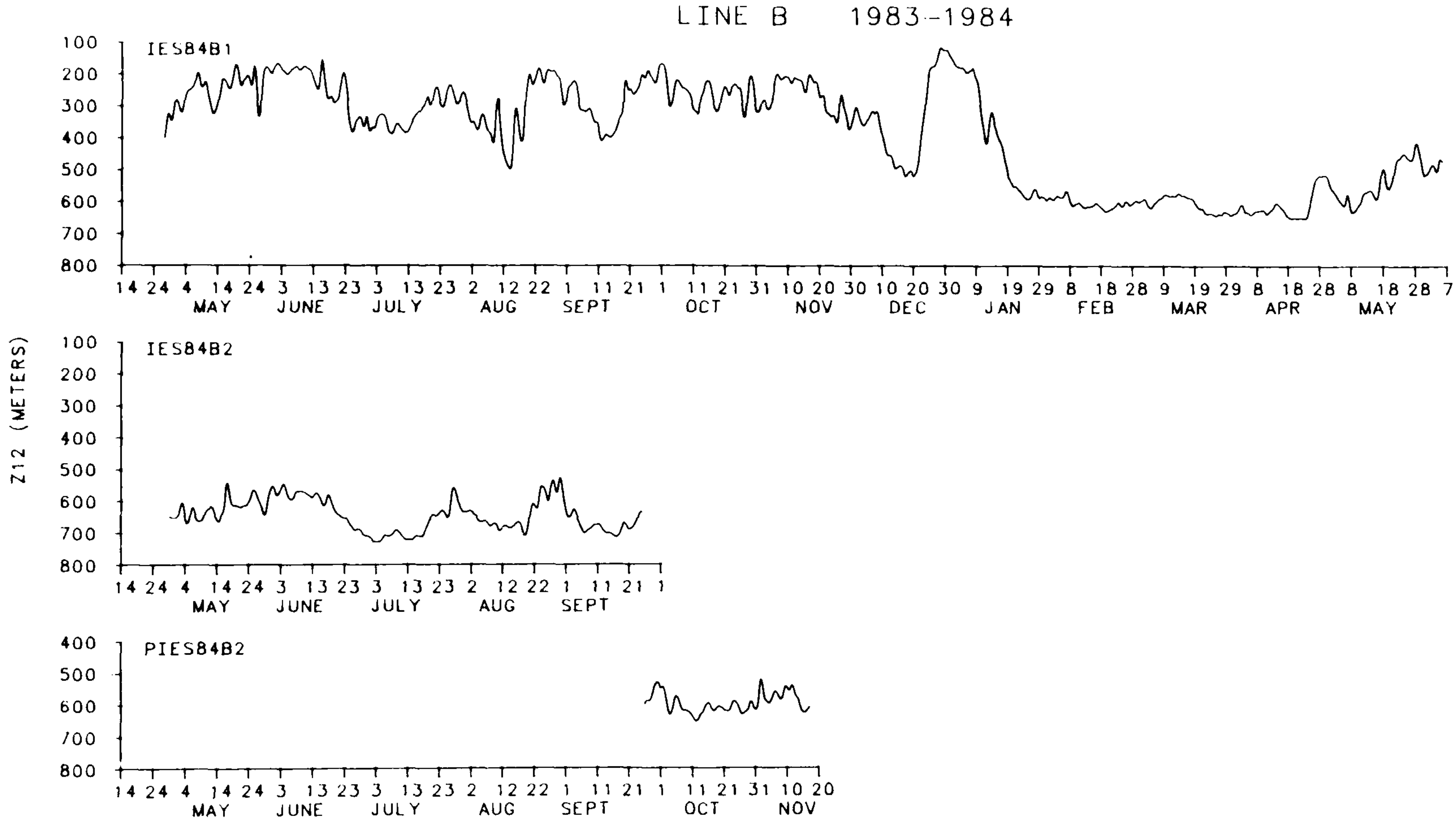


Figure 7.1

Figure 7.1-6 40 HRLP thermocline depth data along lines B to G.

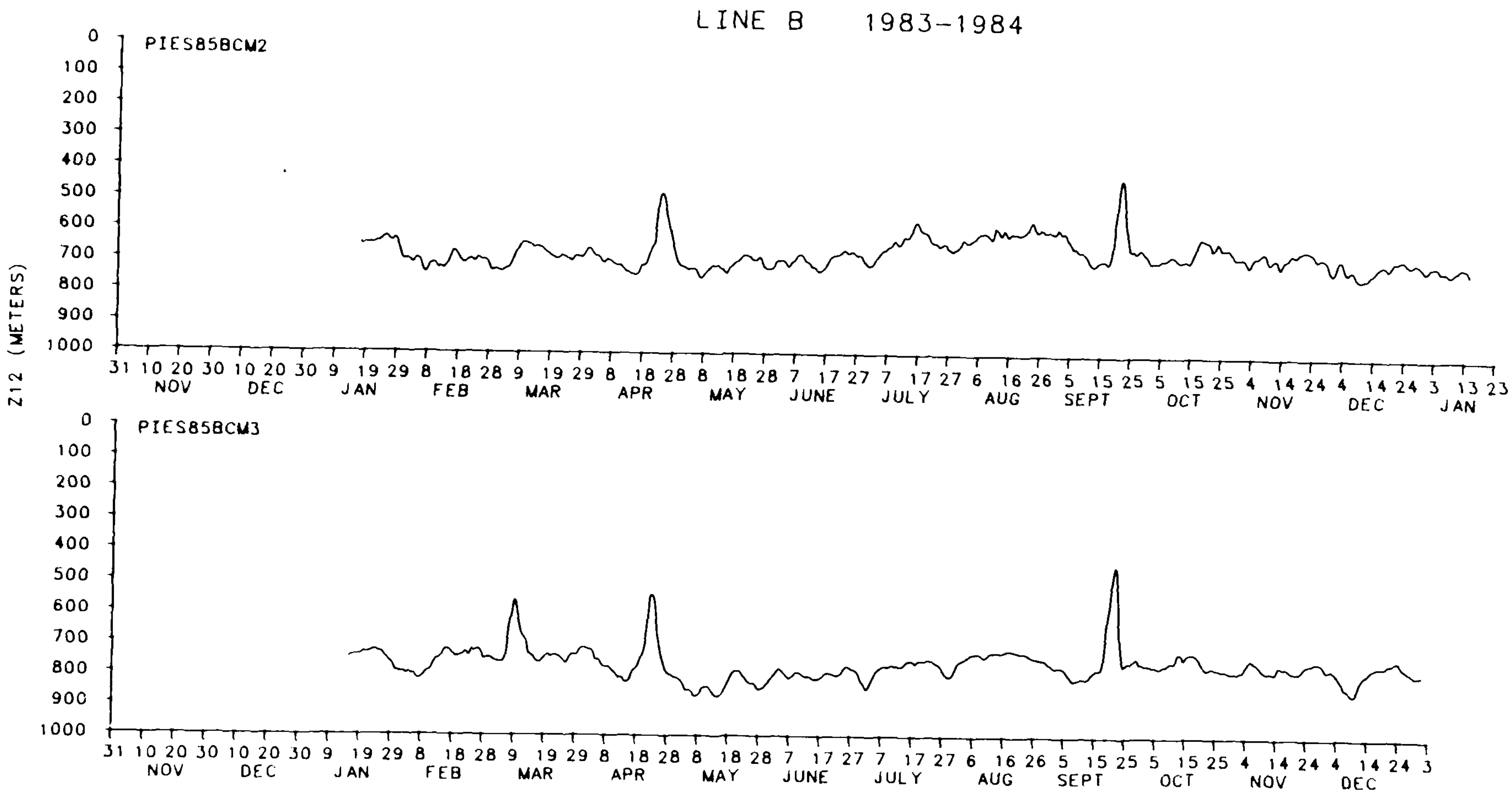
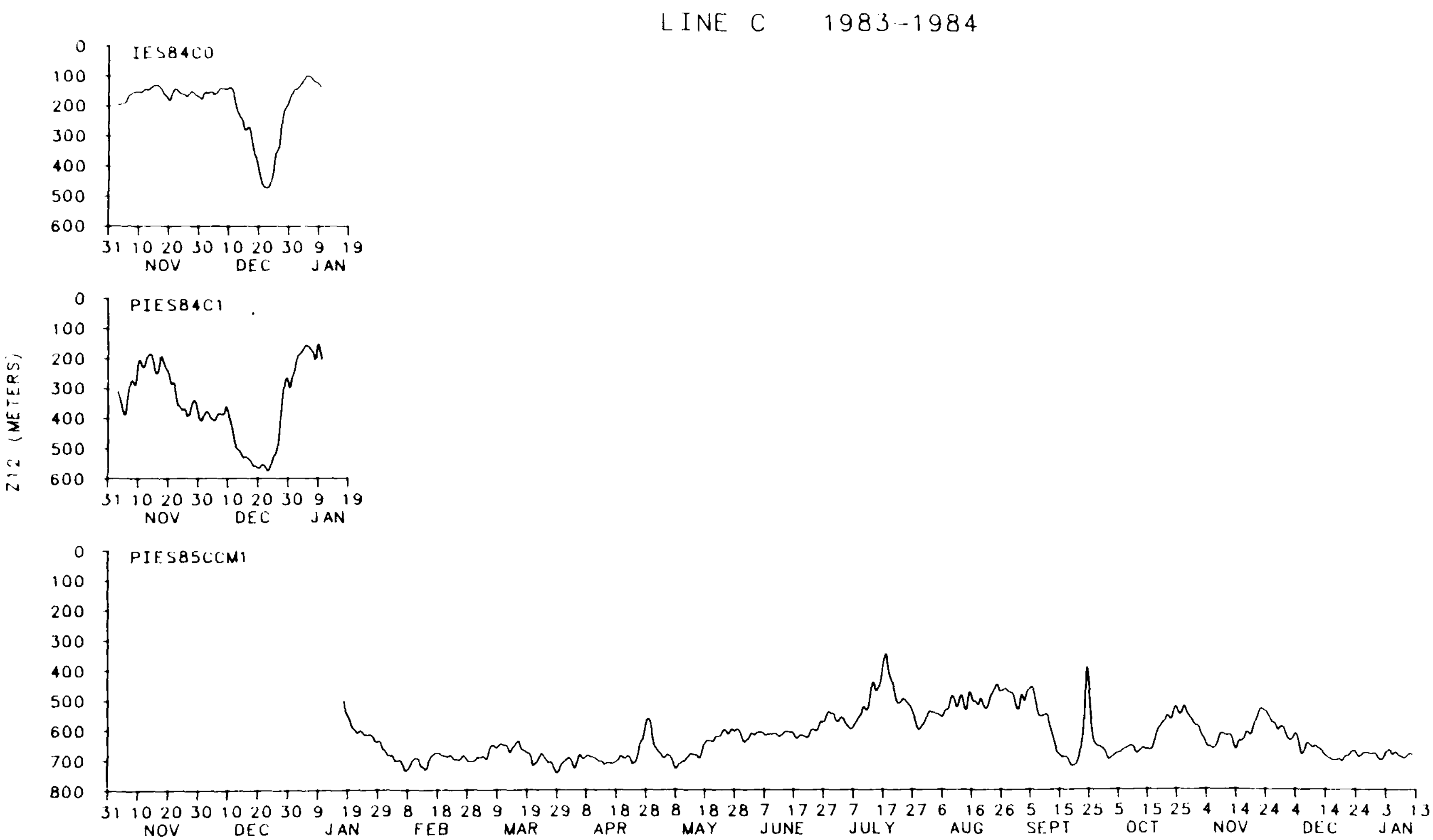


Figure 7.1 (continued)



LINE C 1983-1984
Z12 (METERS)
IES84C0
PIES84C1
PIES85CCM1
0
100
200
300
400
500
600
700
800
31 10 20 30 10 20 30 9 19
NOV DEC JAN
31 10 20 30 10 20 30 9 19 29 8 18 28 9 19 29 8 18 28 8 18 28 7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13
NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN

Figure 7.2

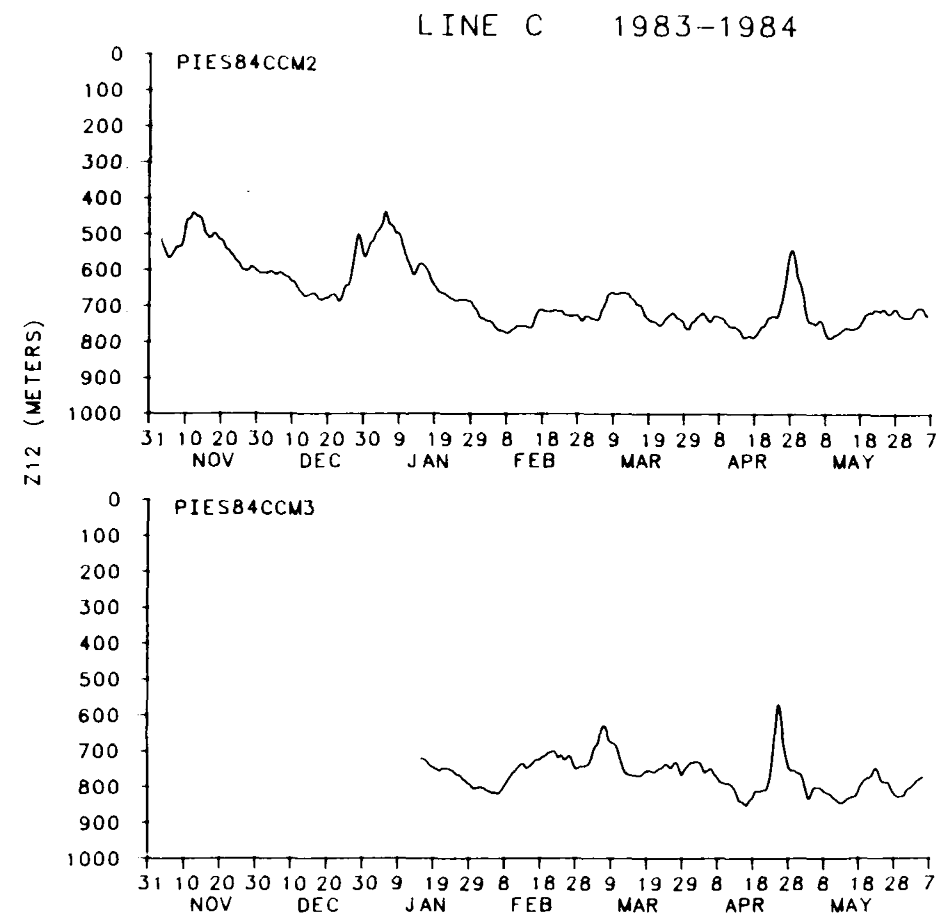


Figure 7.2 (continued)

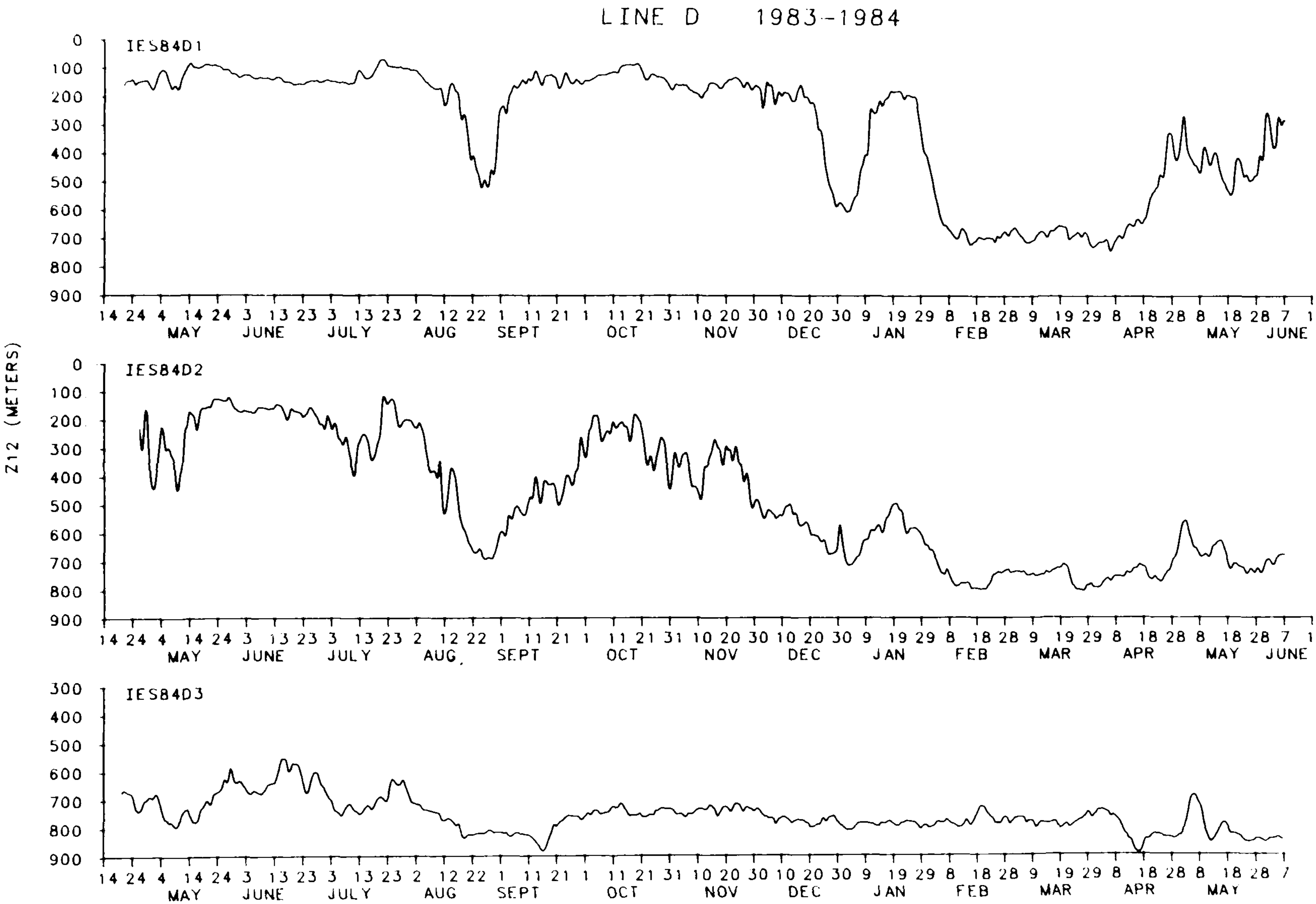

LINE D 1983-1984
IES84D1
IES84D2
IES84D3
Z12 (METERS)
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR

Figure 7.3

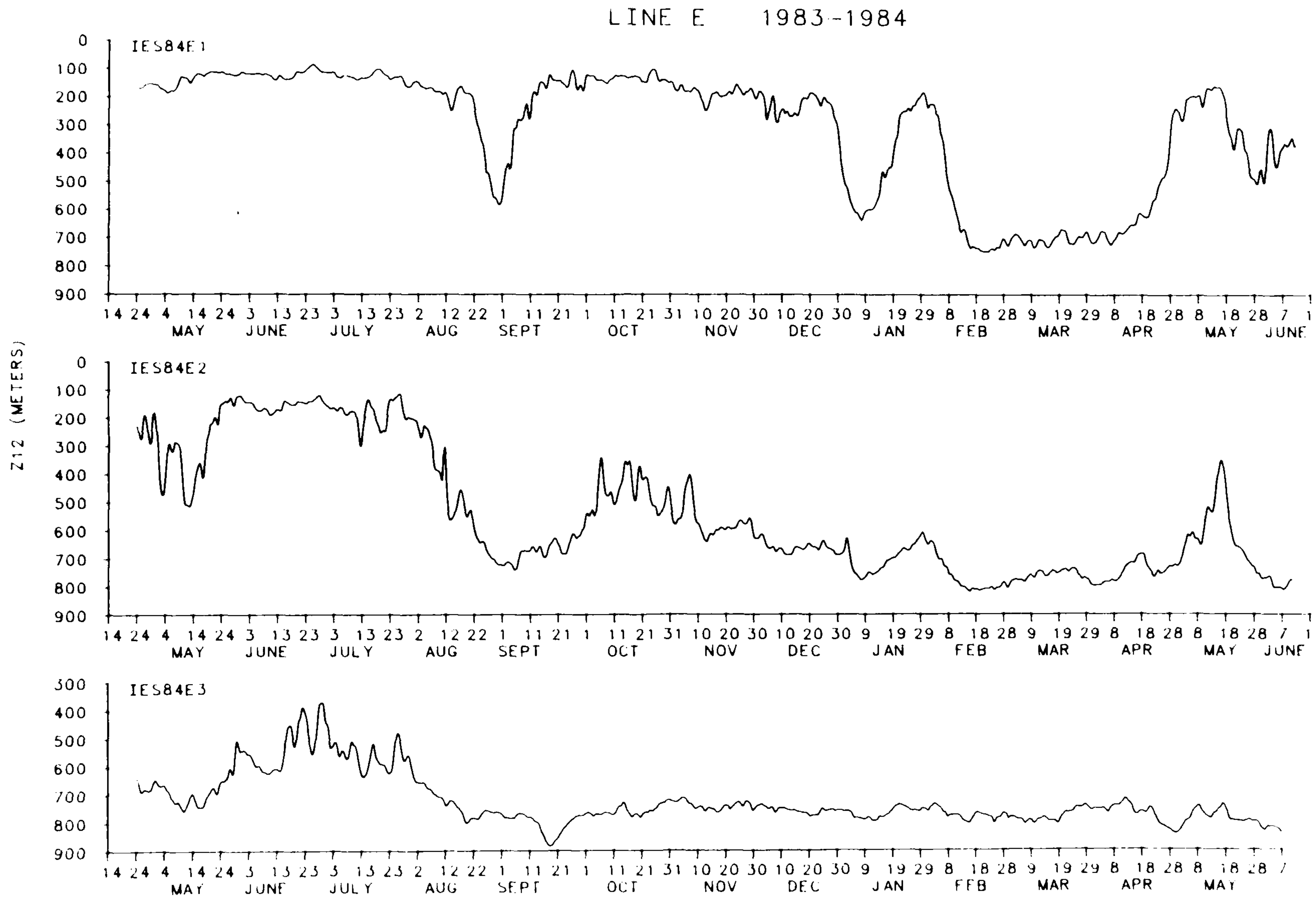

LINE E 1983-1984
IES84E1
IES84E2
IES84E3
Z12 (METERS)
MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE

Figure 7.4

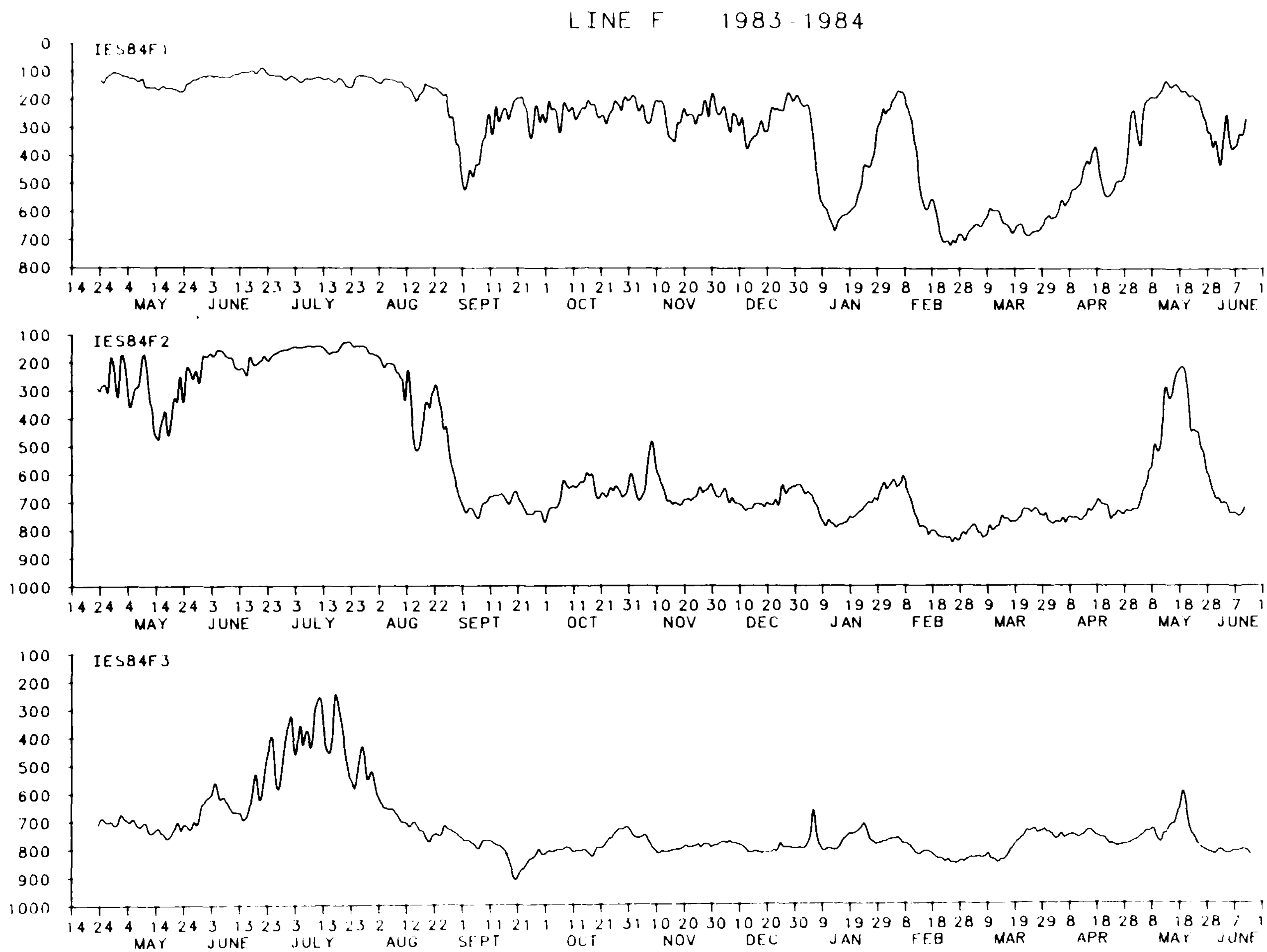
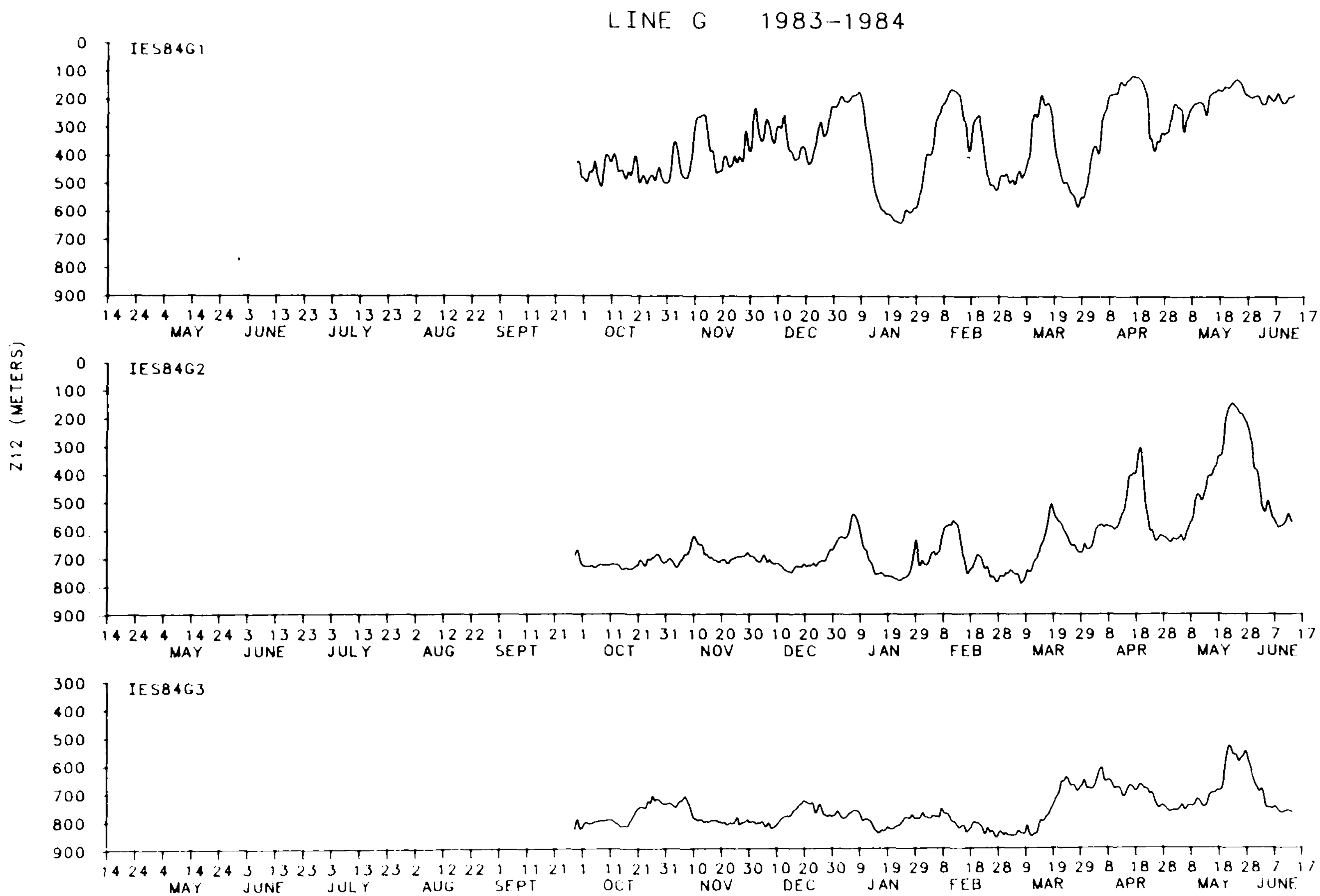

LINE F 1983-1984
IES84F1
IES84F2
IES84F3
Z12 (METERS)
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE

Figure 7.5



LINE G 1983-1984
IES84G1
IES84G2
IES84G3
Z12 (METERS)
0
100
200
300
400
500
600
700
800
900
14 24 4 14 24 3 13 23 3 13 23 2 12 22 1 11 21 1 11 21 31 10 20 30 10 20 30 9 19 29 8 18 28 9 19 29 8 18 28 8 18 28 7 17
MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE

Figure 7.6

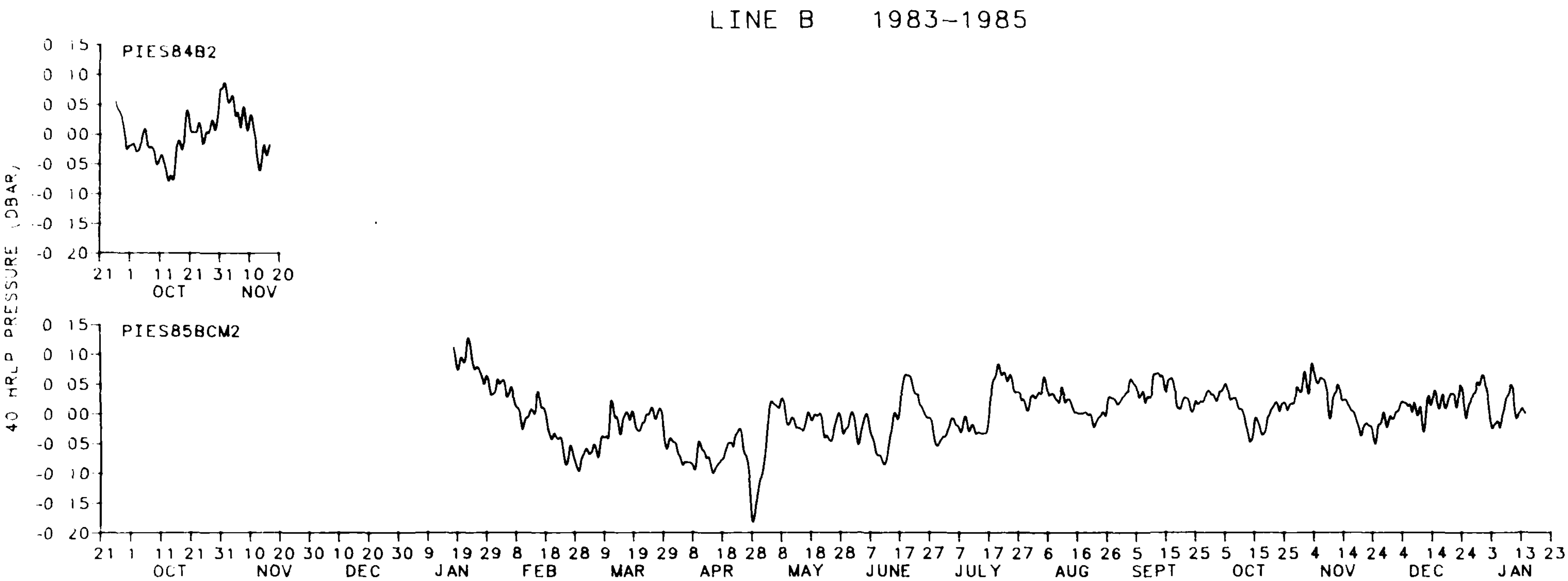


Figure 8.1

Figure 8.1-2 40 HRLP bottom pressure data for lines B and C.

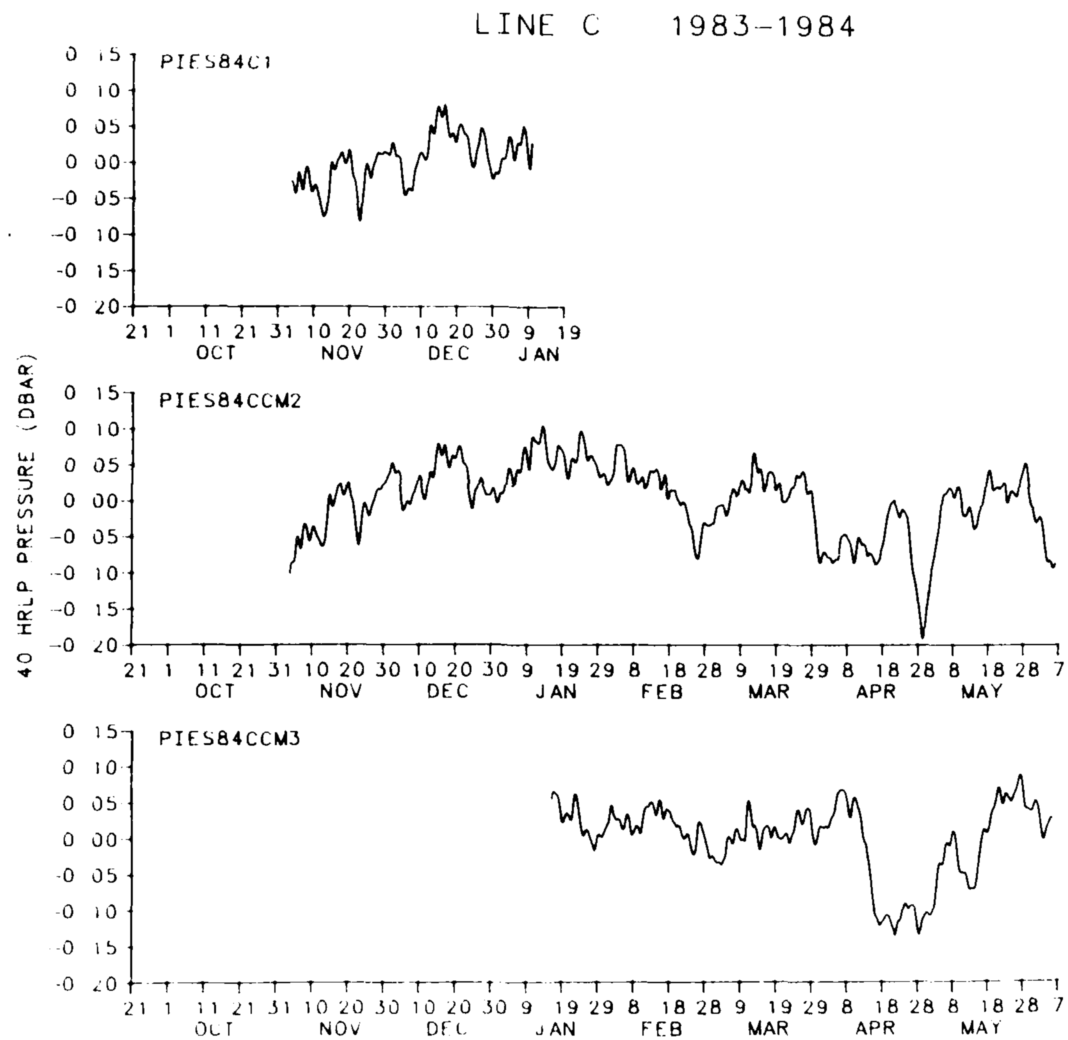

LINE C 1983-1984
PIES84C1
PIES84CCM2
PIES84CCM3
40 HRLP PRESSURE (DBAR)
0 15
0 10
0 05
0 00
-0 05
-0 10
-0 15
-0 20
21 1 11 21 31 10 20 30 10 20 30 9 19 29 8 18 28 9 19 29 8 18 28 8 18 28 7
OCT NOV DEC JAN FEB MAR APR MAY

Figure 8.2

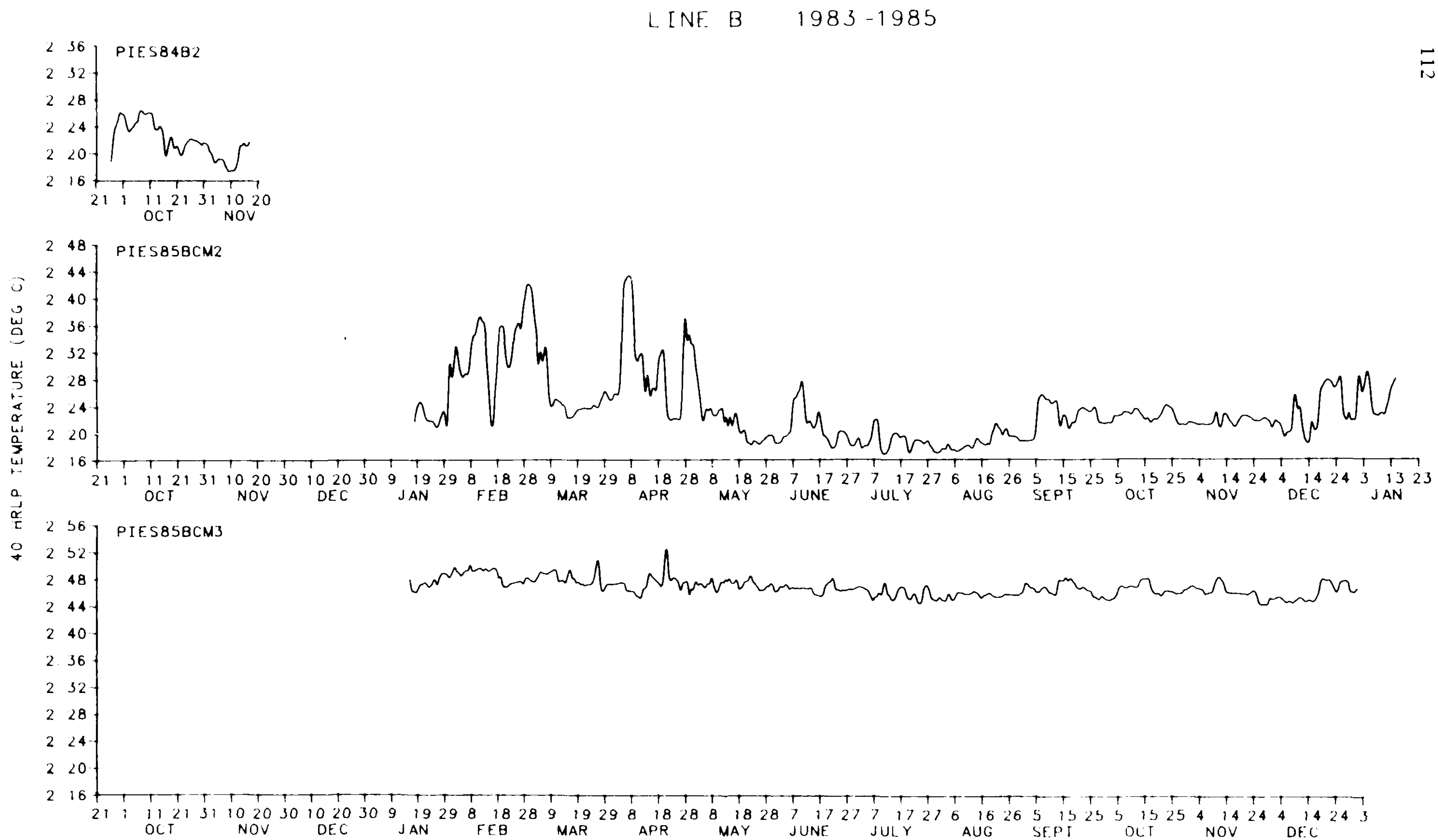
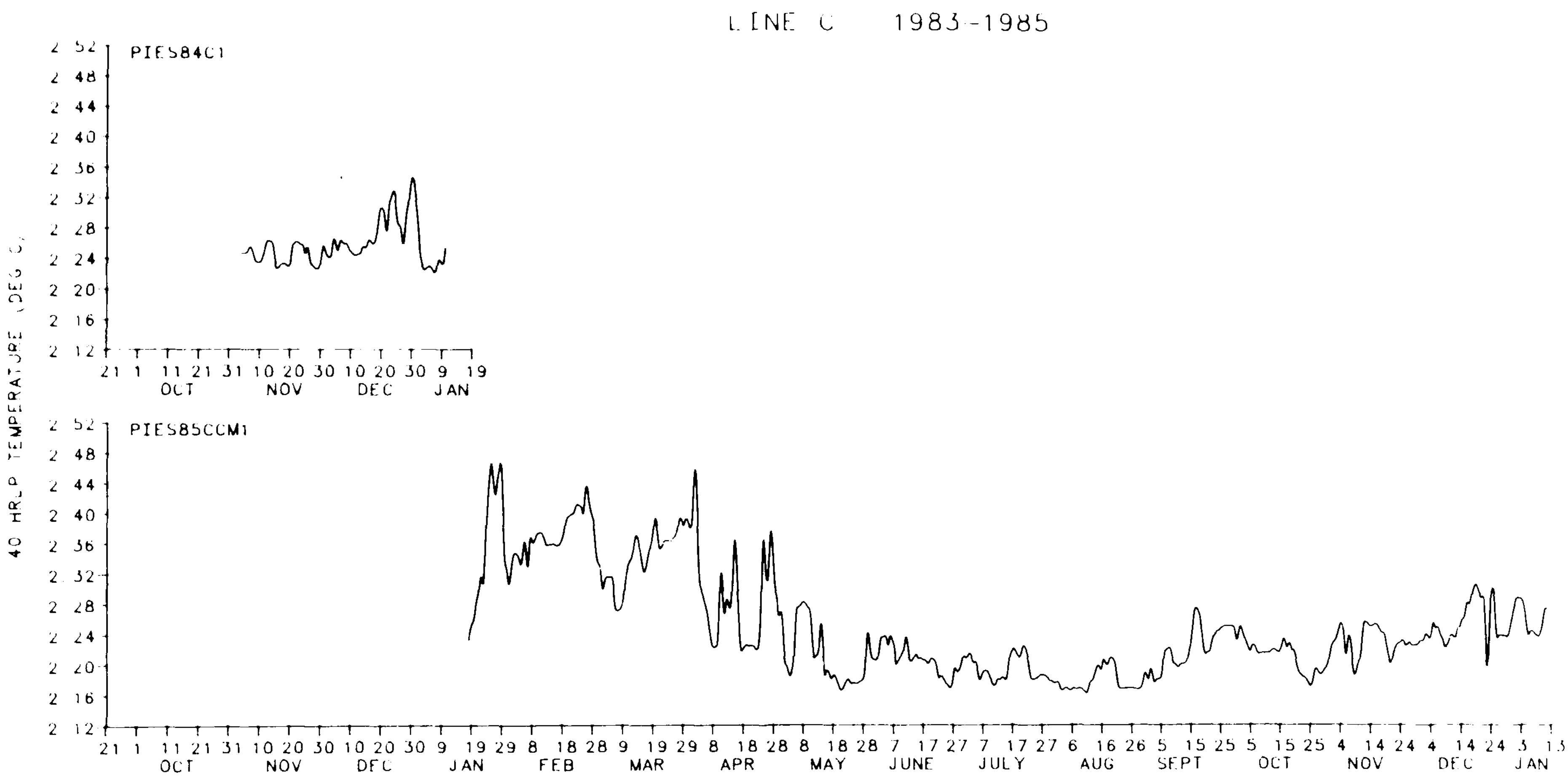


Figure 9.1

Figure 9.1-2 40 HRLP temperature data for lines B and C.



LINE C 1983-1985
PIES84C1
PIES85CCM1
40 HRLP TEMPERATURE (DEG C)
2 52
2 48
2 44
2 40
2 36
2 32
2 28
2 24
2 20
2 16
2 12
21 1 11 21 31 10 20 30 10 20 30 9 19
OCT NOV DEC JAN
21 1 11 21 31 10 20 30 10 20 30 9 19 29 8 18 28 9 19 29 8 18 28 8 18 28 7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13
OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN

Figure 9.2

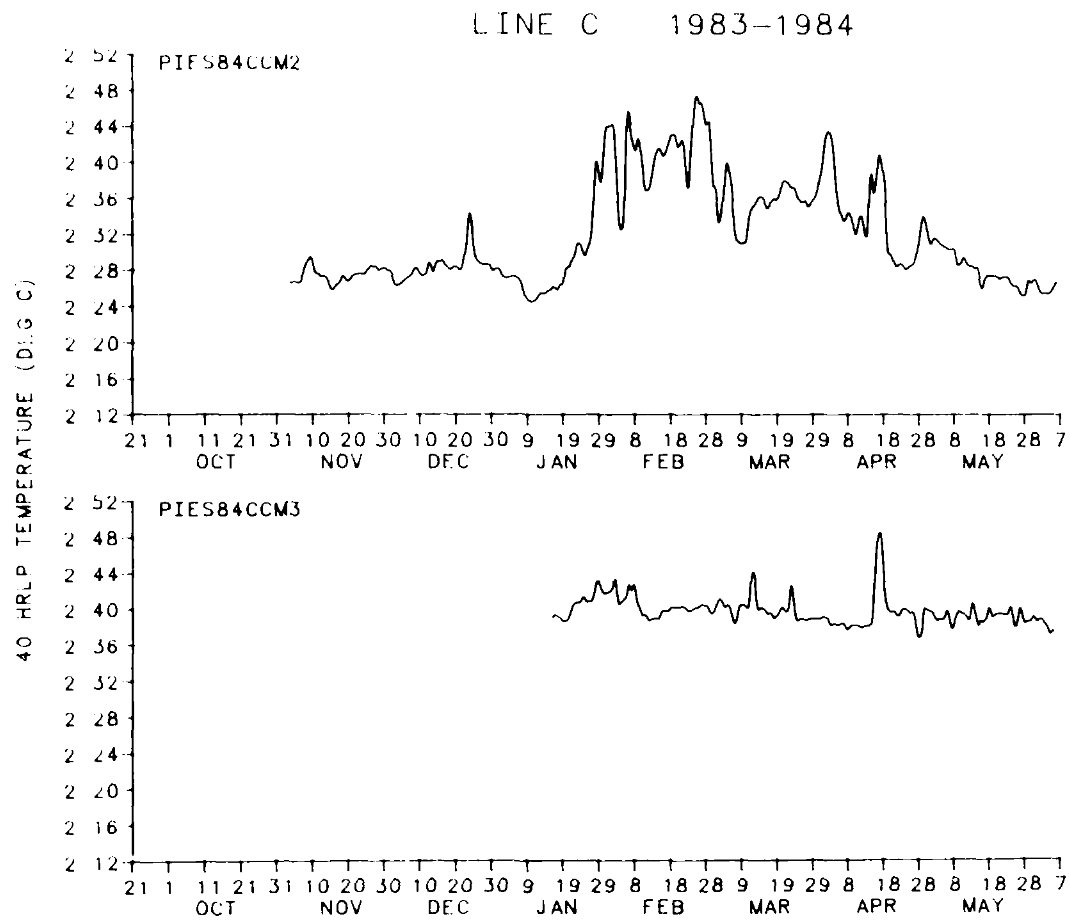


Figure 9.2 (continued)

SECTION 5

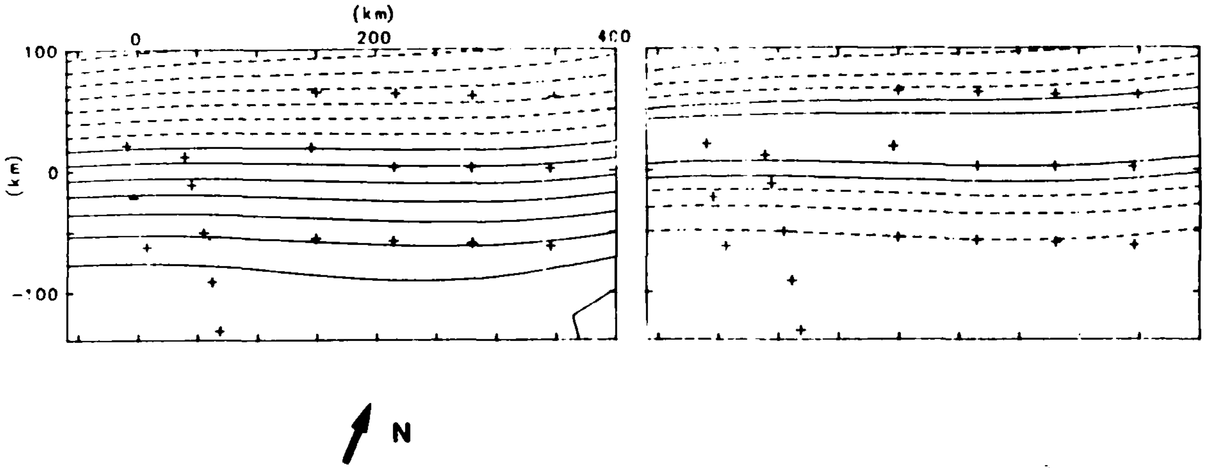
Thermocline Depth Maps

Contour plots of the mean and standard deviation fields, the error fields, the thermocline depth (Z_{12}) fields, and the perturbation fields are presented.

Three different sizes of regions are mapped, depending on the number and location of the instrumented sites. These are: a) From April to September 1983, the region is 200 km cross-stream by 400 km downstream. b) From September 1983 to January 1984, it is 200 km by 460 km. c) From January to June 1984, it is 240 km by 460 km. The inset in Figure 10 shows the relationship of these regions to each other; the upper left-hand corner of all three regions corresponds to the same location. In Figures 10-12, each of the contoured frames corresponds to either the full boxed region in Figure 1 or a portion of it. The boxed region is oriented 064°T, and north is indicated by the arrow in Figure 10. The horizontal scales in Figure 10 apply to the frames in Figures 11 and 12.

Each frame consists of a grid of points at 20 km spacing. The actual IES sites are indicated by the + marks and the positions are listed in Table 1. From January to June 1984, Z_{12} data was available from two additional IESs, IES85C4 and IES85C5. These data have been included in the mapped fields. Additionally, during June 1984, most of the IESs documented in this report were recovered and redeployed at the same locations. Thus for 9-16 June 1984, the most accurate Z_{12} maps

were obtained by combining the data records from both deployment periods. The positions of the instruments and their data records from the June 1984 to May 1985 deployment are presented in Tracey et al. (1985).



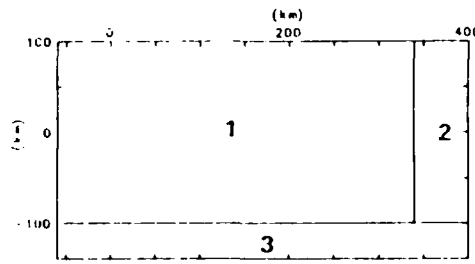


Figure 10. Mean field (above left) for the April 1983 to June 1984 data and the root-mean-square standard deviation field (above right) are contoured in plan view. Contour interval of the mean field is 50 m, with dashed lines indicating $Z_{12} \leq 500$m. Contour interval of the standard deviation field is 25 m, with the dashed region corresponding to standard deviation $\leq$ 150 m rms. North is indicated by the arrow. The inset (right) shows the three regions which are mapped in Figures 11 and 12: a) Area 1 corresponds to the region mapped from 28 April to 26 September 1983 (200 x 400 km). b) The combined areas 1 and 2 were mapped from 27 September 1983 to 12 January 1984 (200 x 460 km). c) The full region, areas 1, 2, and 3, was mapped from 13 January to 16 June 1984 (240 x 460 km).

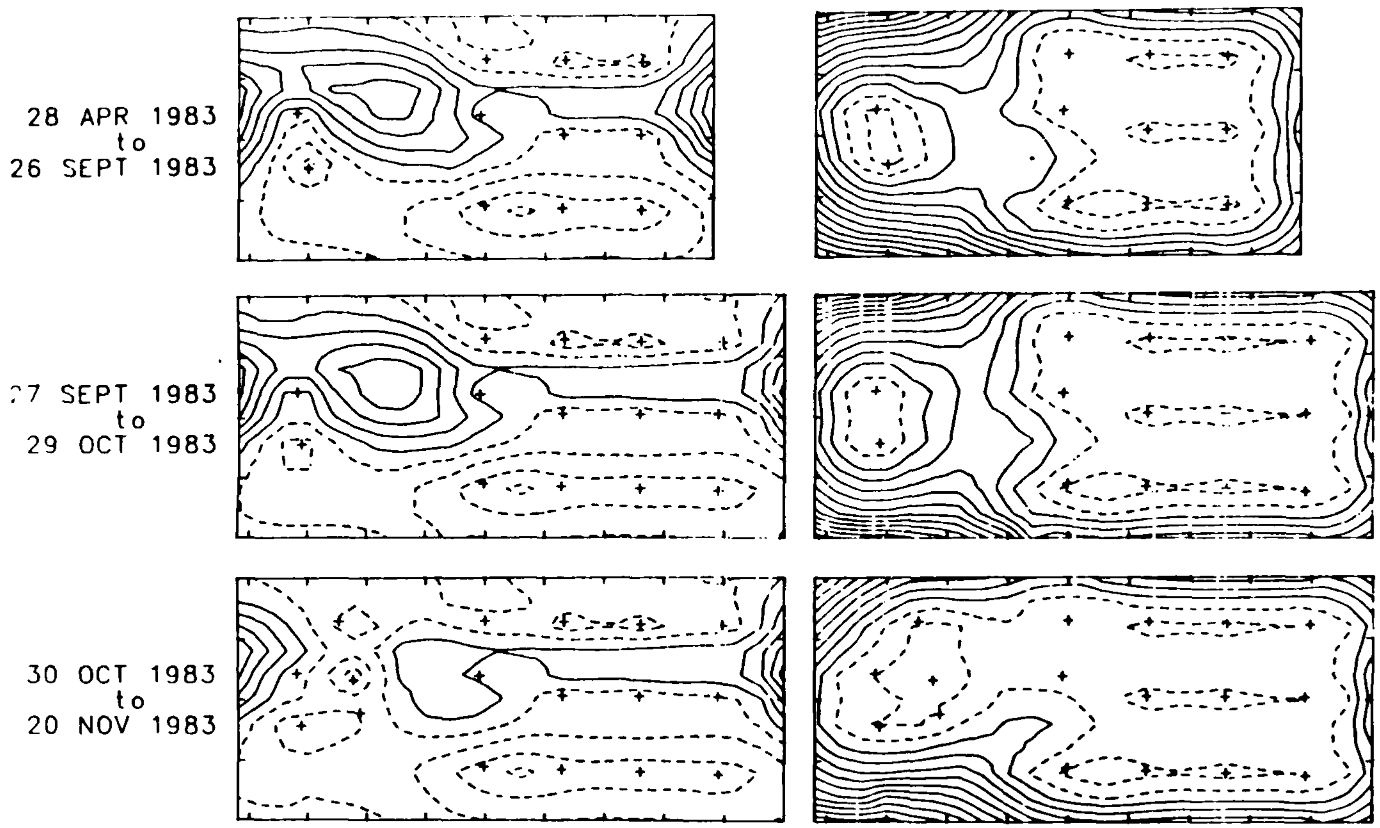
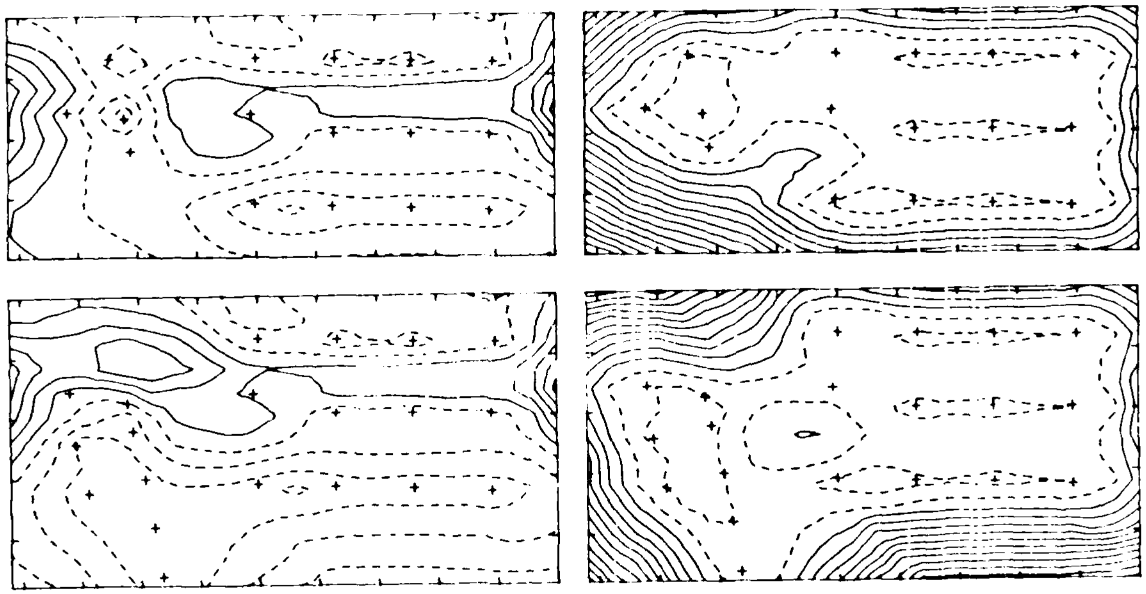


Figure 11. The error (percent standard deviation) fields, shown at right, are contoured at 5% intervals, with the dashed region corresponding to < 15% error. The error-bar fields (left) have a contour interval of 10 m and the dashed region corresponds to errors < 50 m. The five sets of error maps apply to the Z_{12} and perturbation fields in Figure 12 for the dates shown. The horizontal scales are the same as those labelled in Figure 10, with the upper-left-hand corner of all frames corresponding to the same location.

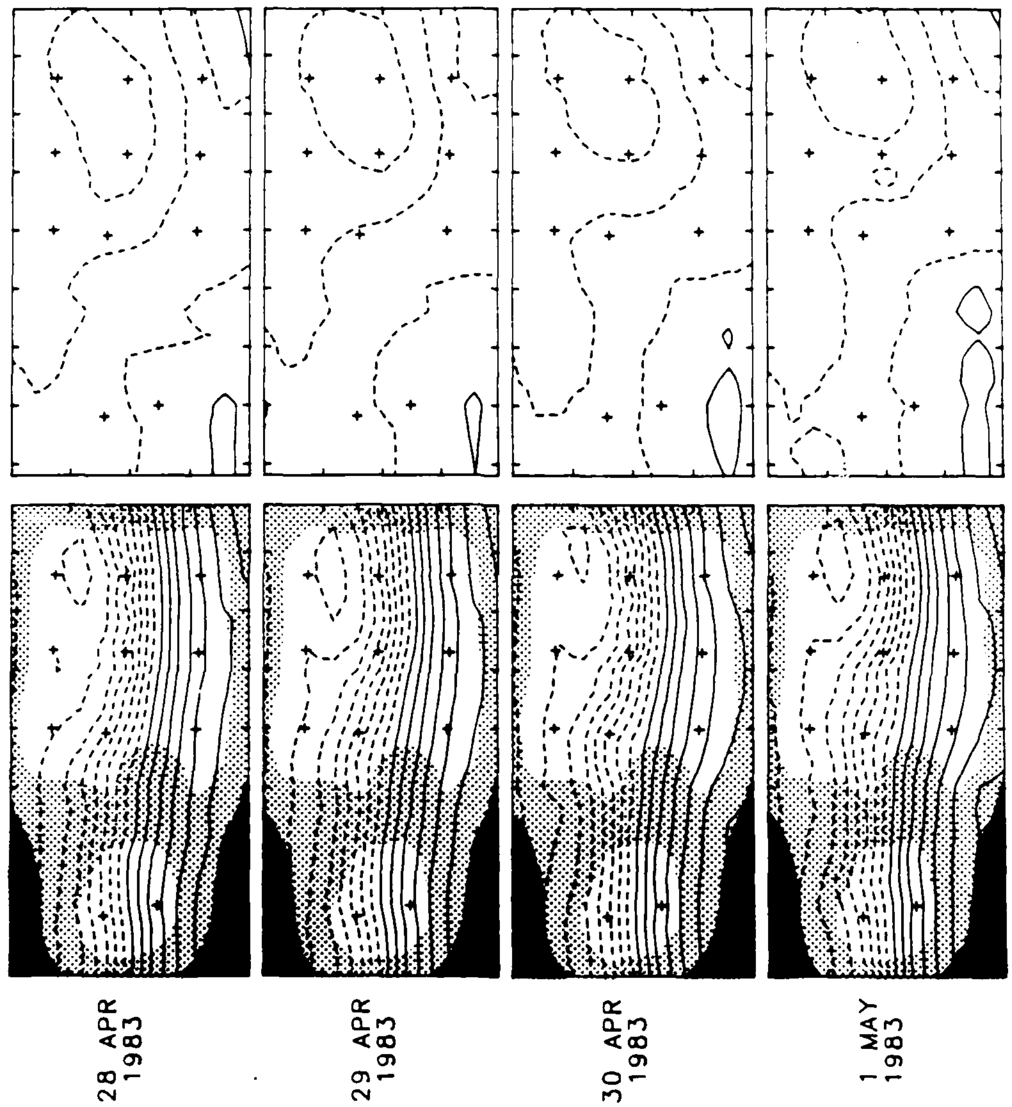


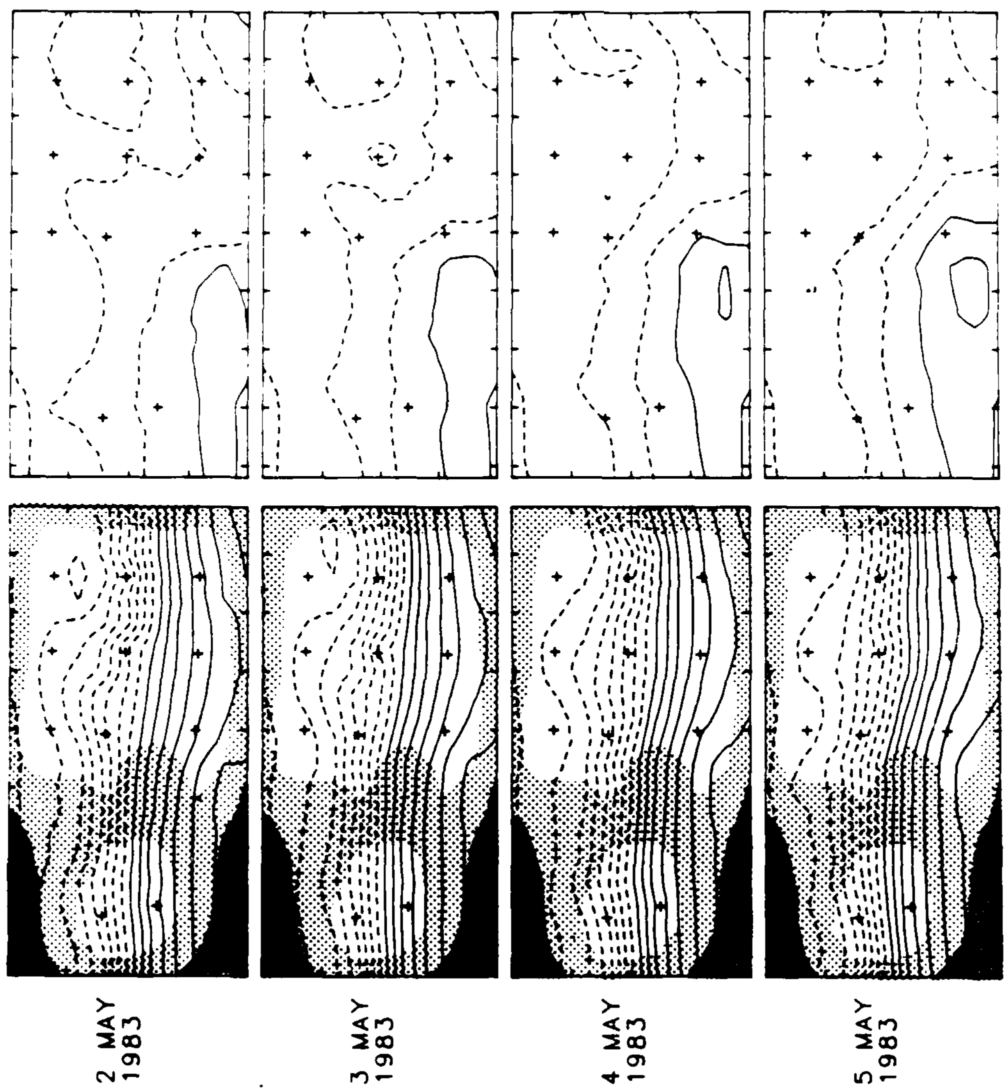
21 NOV 1983
to
12 JAN 1984

13 JAN 1984
to
16 JUNE 1984

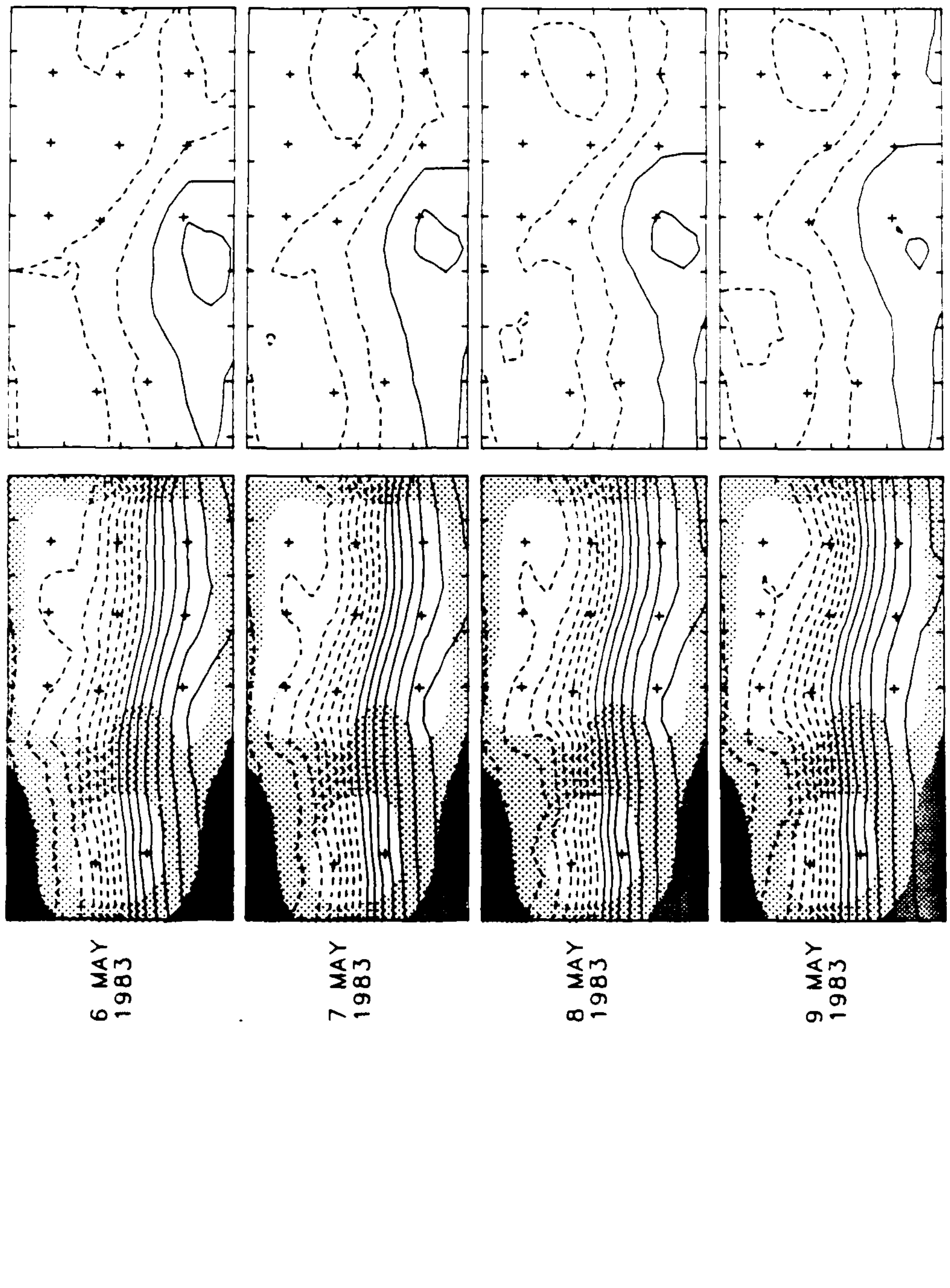
Figure 11 (continued)

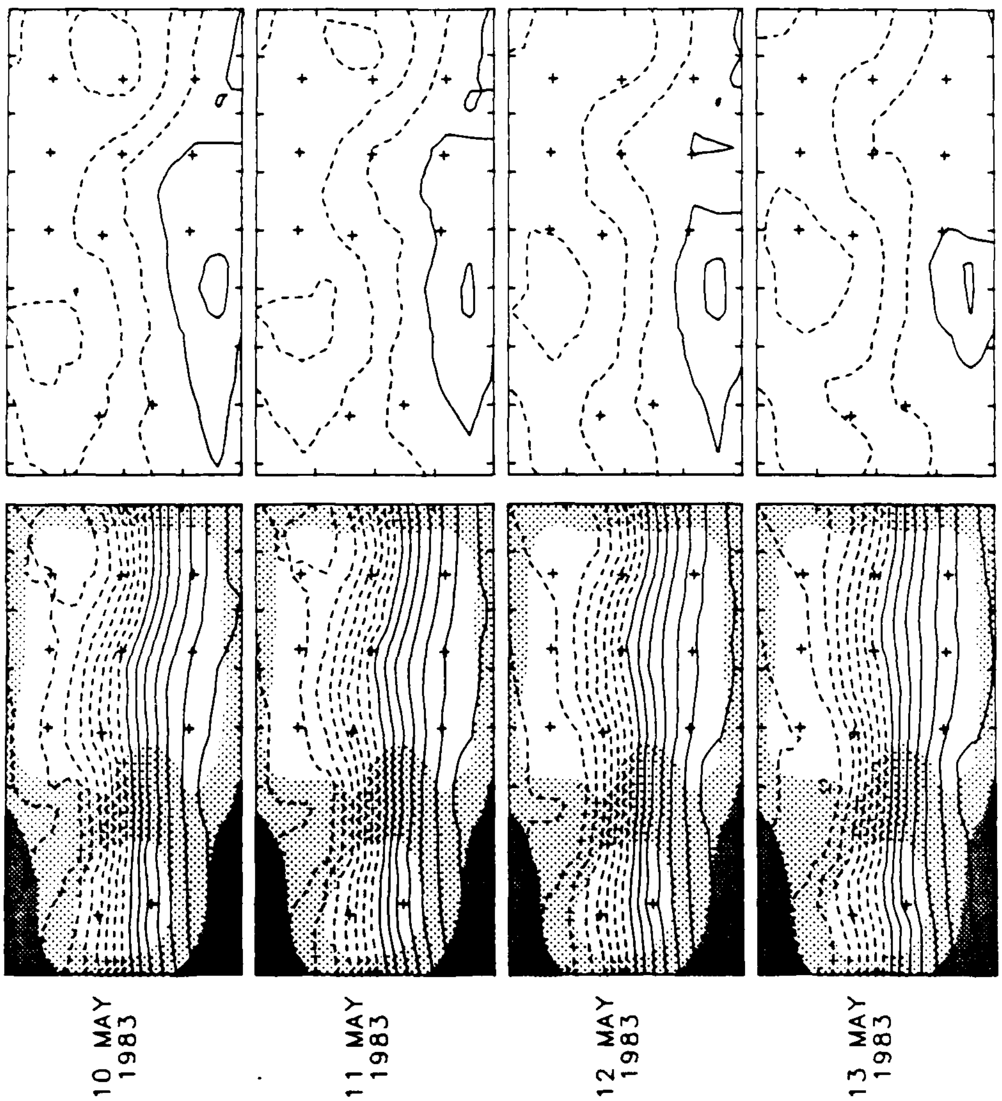
Figure 12. The 12°C isotherm depth, Z_{12}, field (left) and the perturbation field (right) are shown at daily intervals from 28 April 1983 to 16 June 1984. The maps are shown for 1200 GMT on the date indicated at the left. Contour interval of the perturbation field is 0.5 with the dashed region corresponding to negative values. The Z_{12} field is contoured at 50 m intervals and depths shallower than 500 m are dashed. The lighter shaded area corresponds to regions of ≥15% estimated error and the darker shading to errors of ≥35% from the error maps shown in Figure 11.

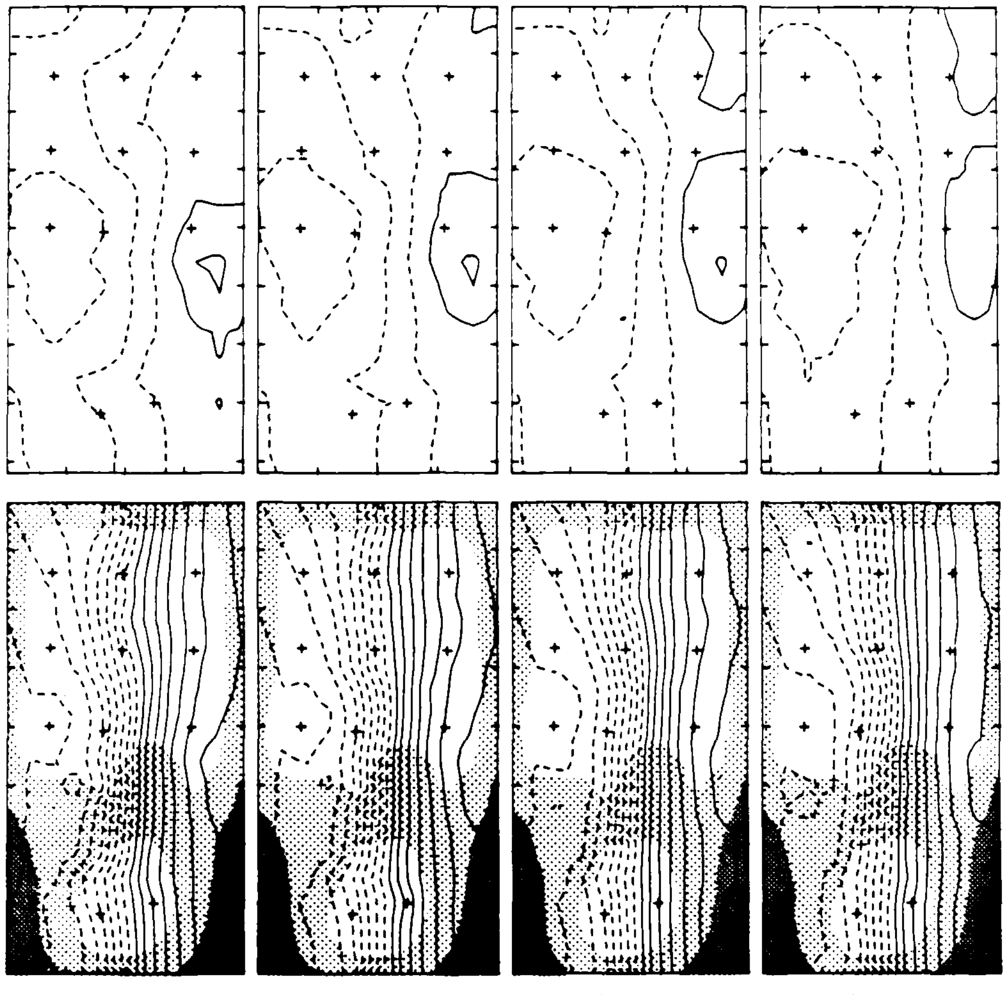

28 APR 1983
29 APR 1983
30 APR 1983
1 MAY 1983



2 MAY 1983
3 MAY 1983
4 MAY 1983
5 MAY 1983


6 MAY
1983
7 MAY
1983
8 MAY
1983
9 MAY
1983


10 MAY 1983
11 MAY 1983
12 MAY 1983
13 MAY 1983

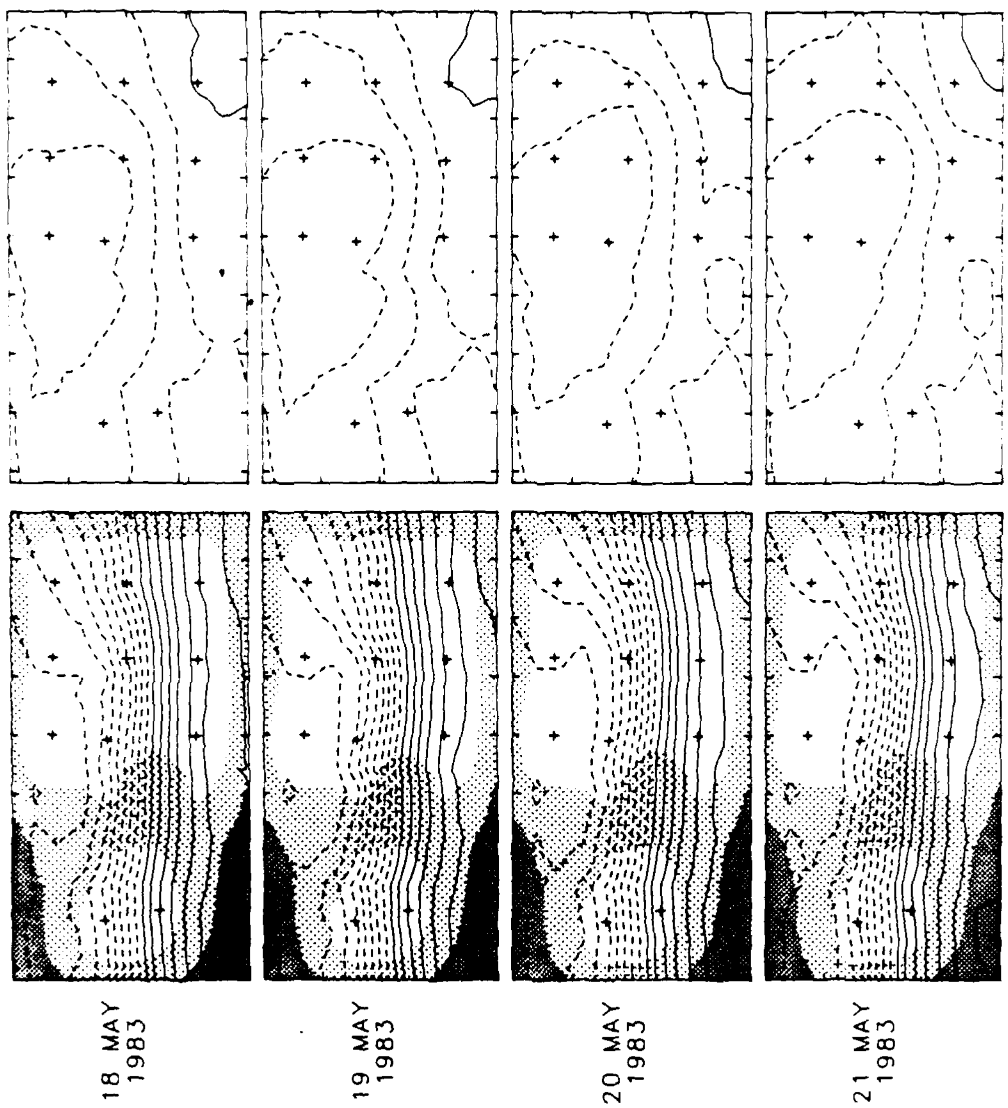


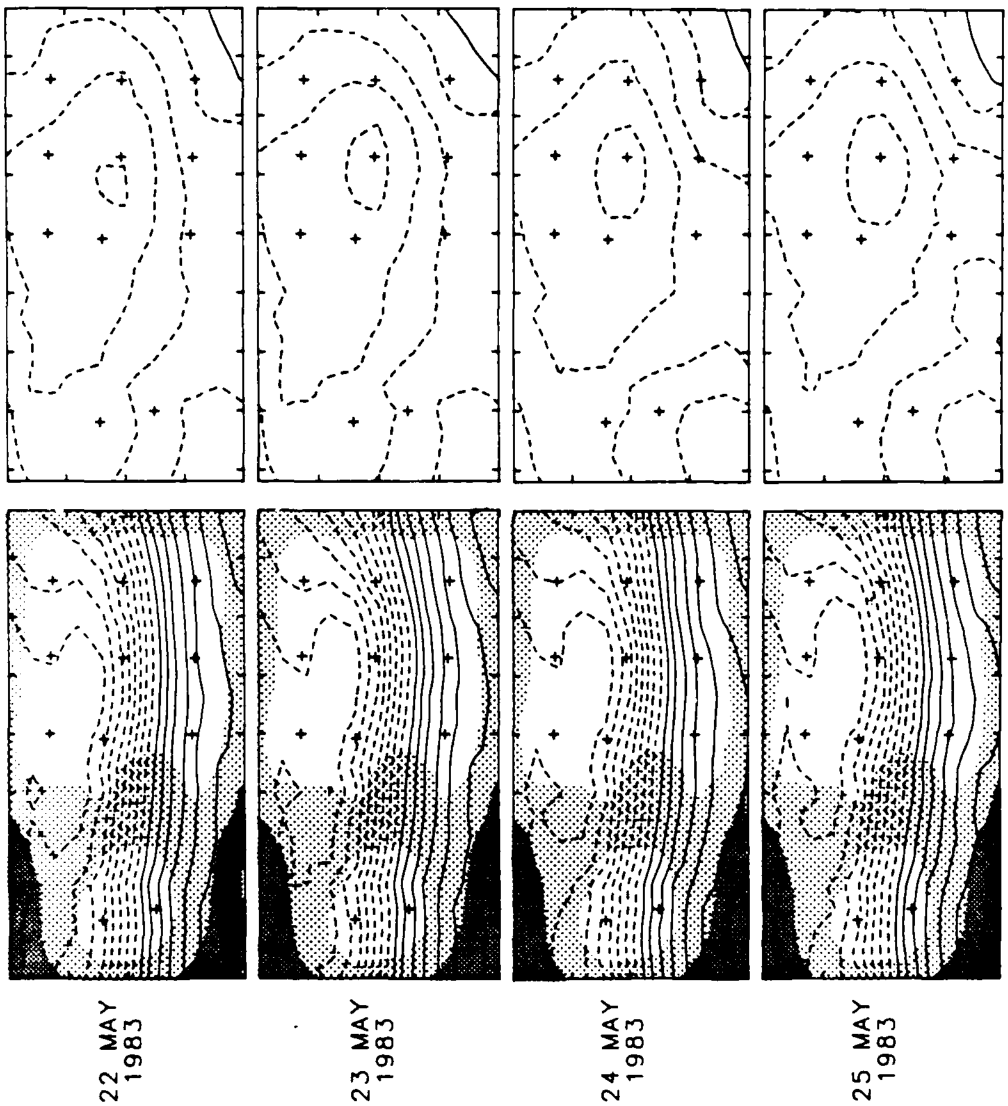
14 MAY 1983

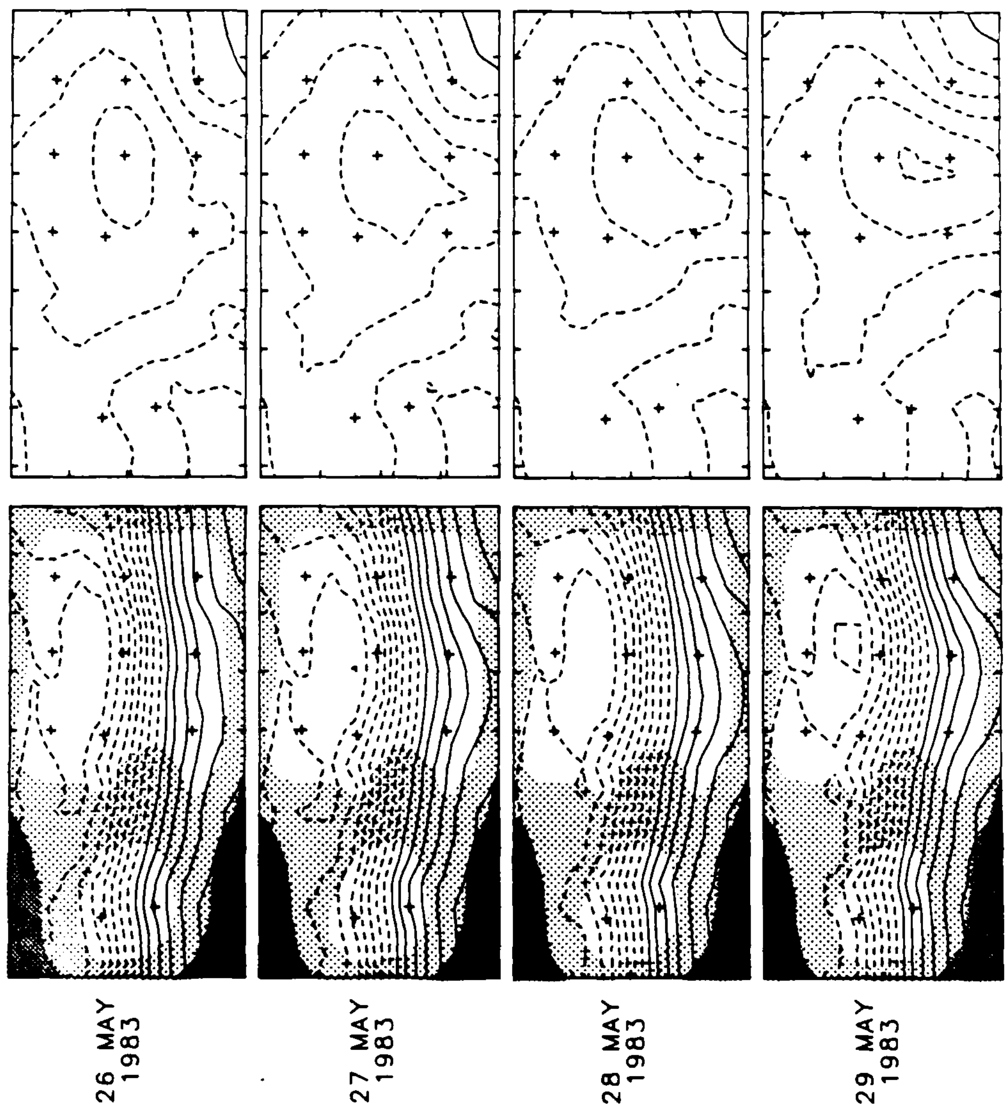
15 MAY 1983

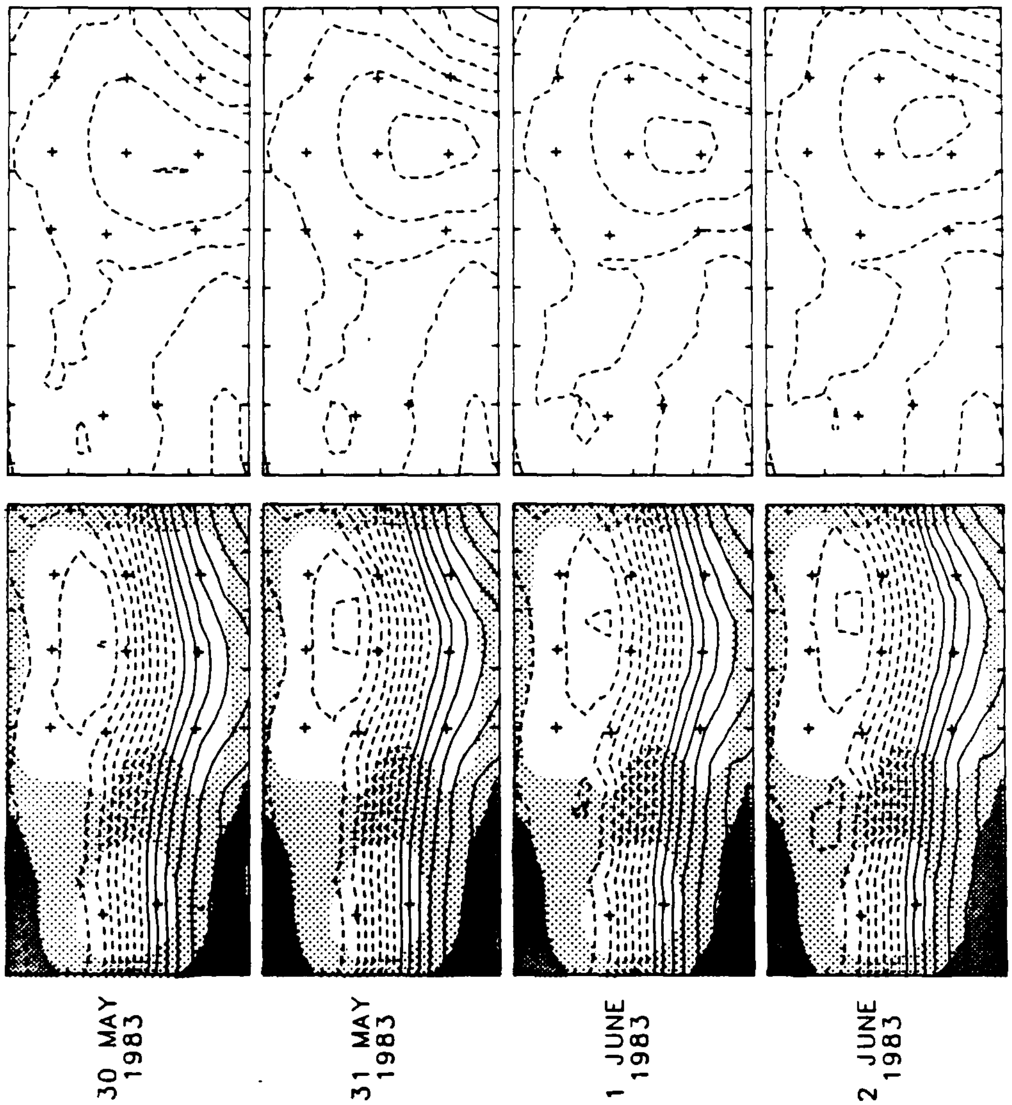
16 MAY 1983

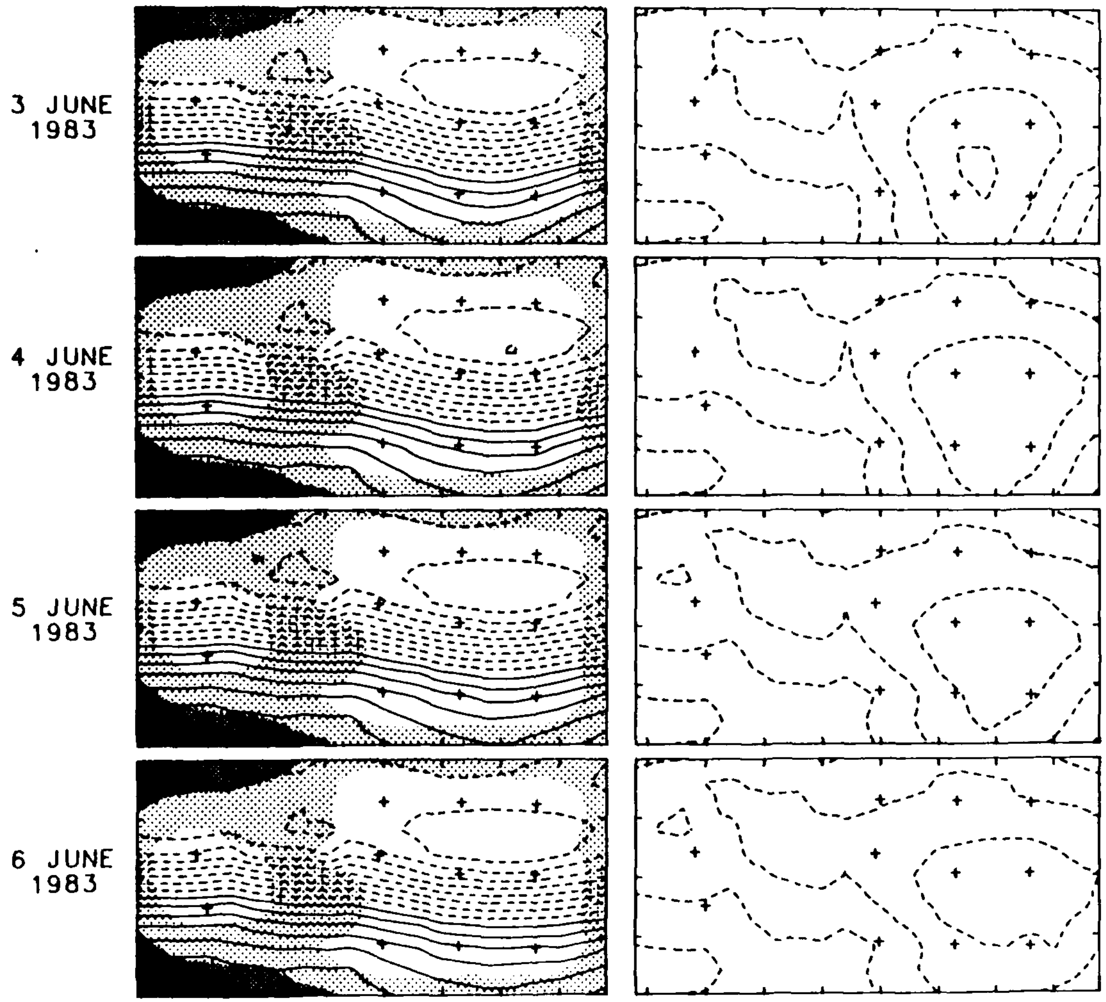
17 MAY 1983

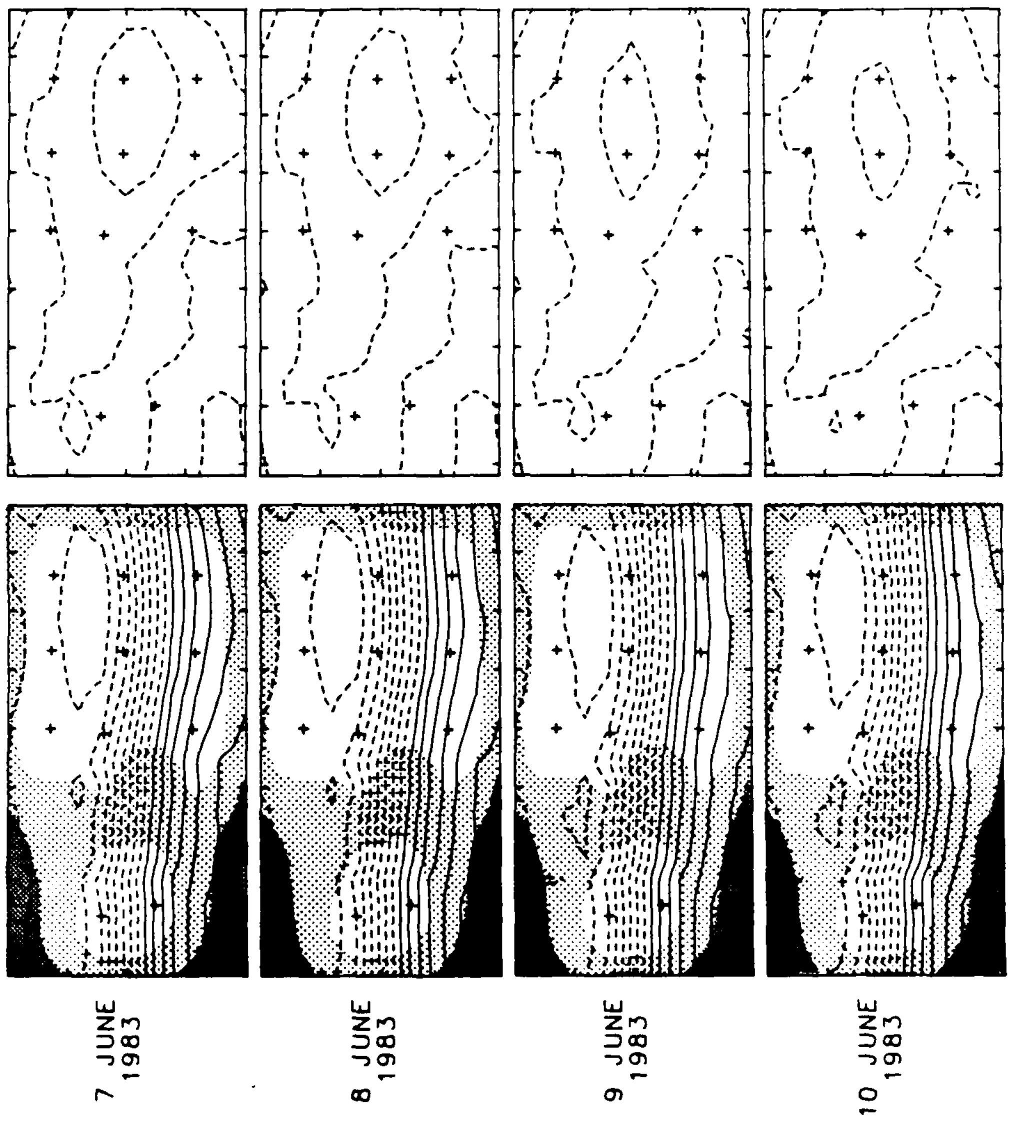

18 MAY 1983
19 MAY 1983
20 MAY 1983
21 MAY 1983

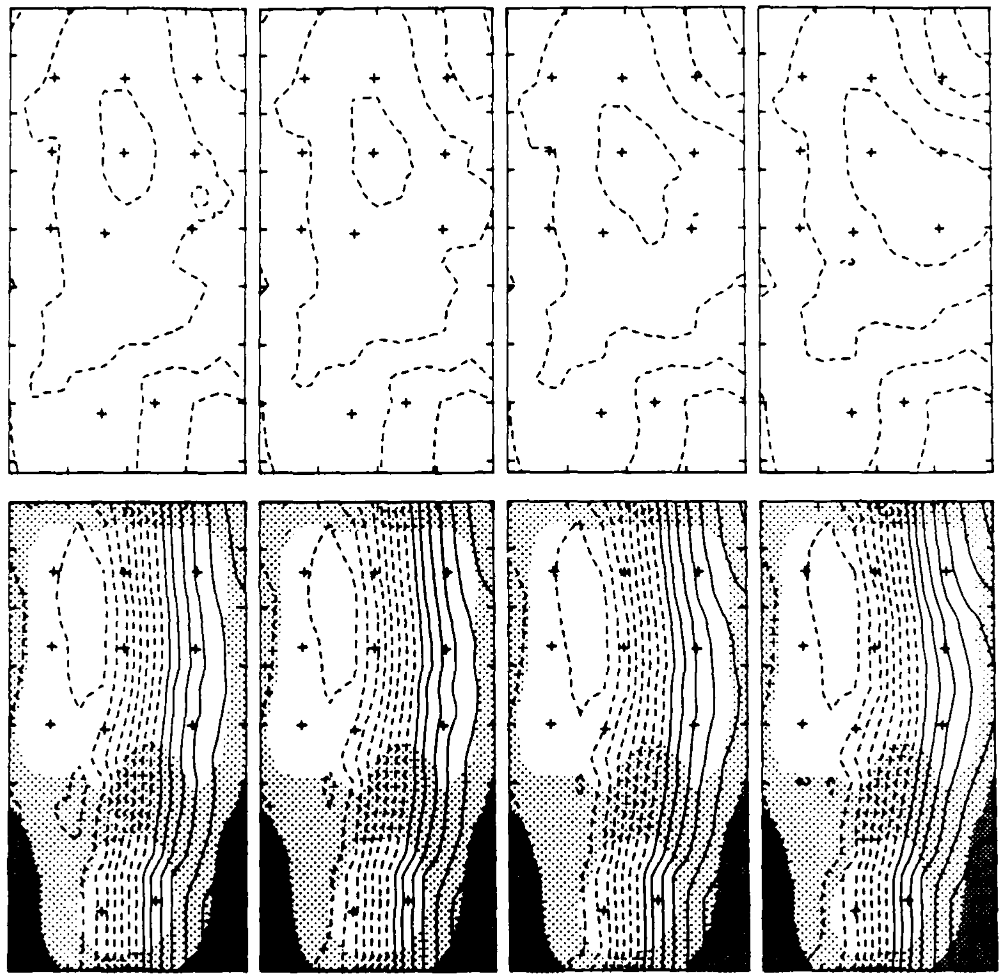

22 MAY 1983
23 MAY 1983
24 MAY 1983
25 MAY 1983


26 MAY 1983
27 MAY 1983
28 MAY 1983
29 MAY 1983


30 MAY 1983
31 MAY 1983
1 JUNE 1983
2 JUNE 1983


3 JUNE 1983
4 JUNE 1983
5 JUNE 1983
6 JUNE 1983


7 JUNE 1983
8 JUNE 1983
9 JUNE 1983
10 JUNE 1983

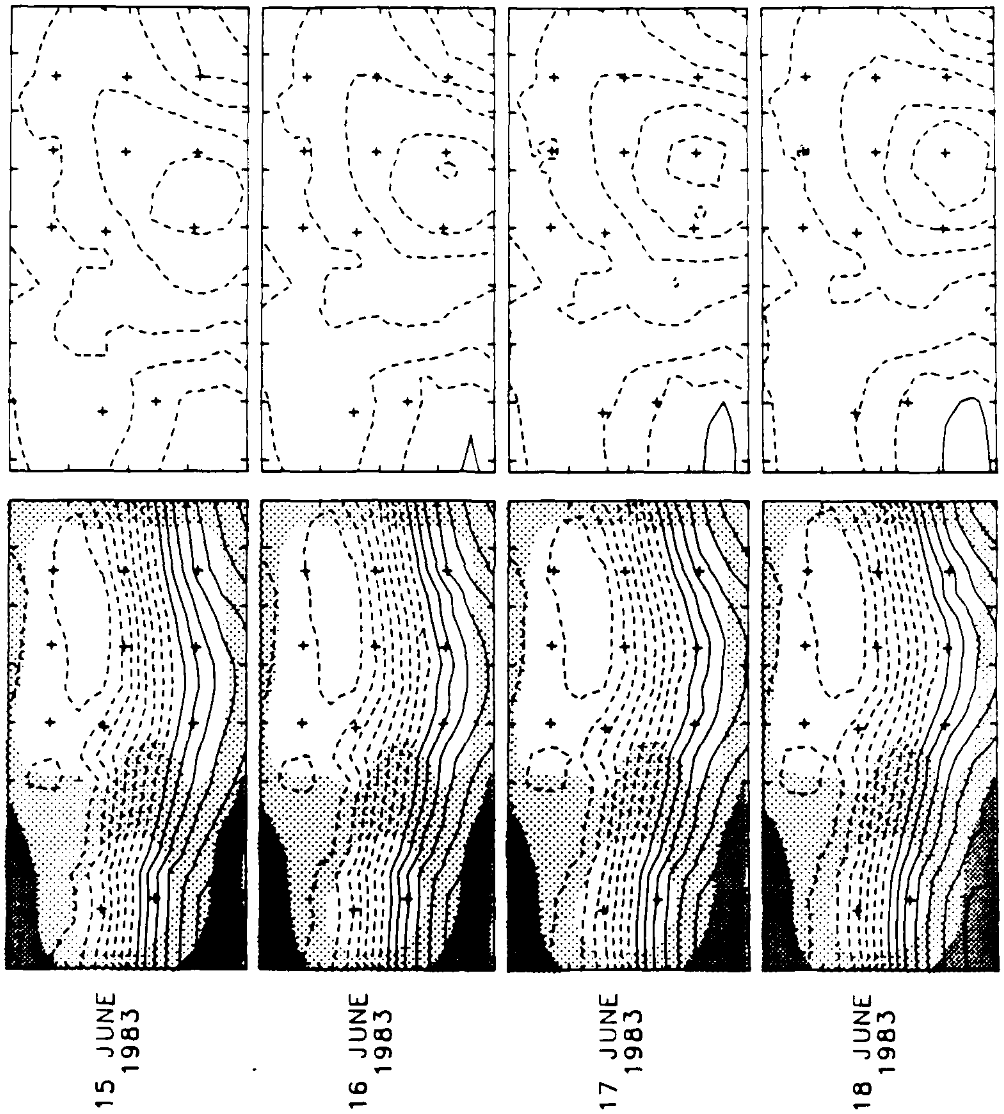


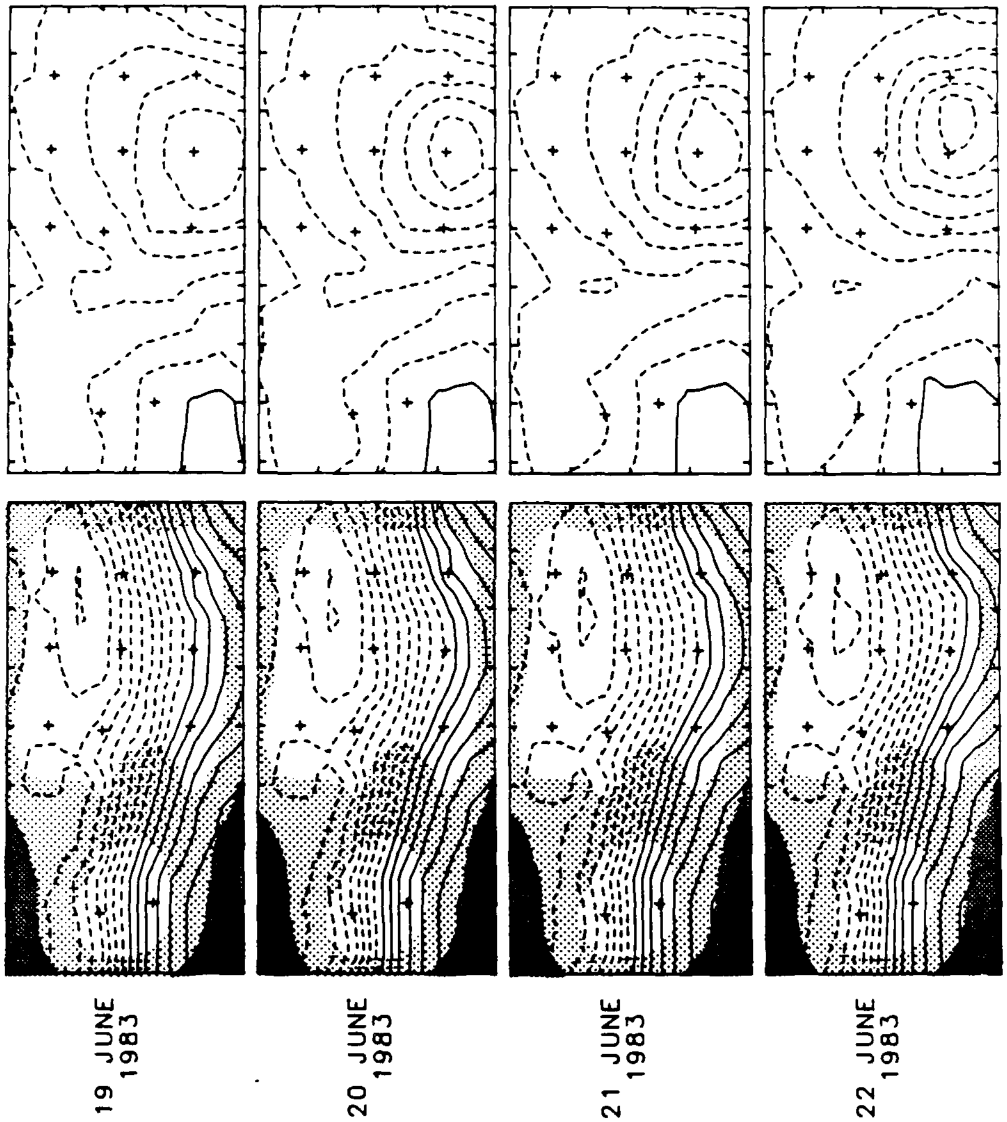
11 JUNE 1983

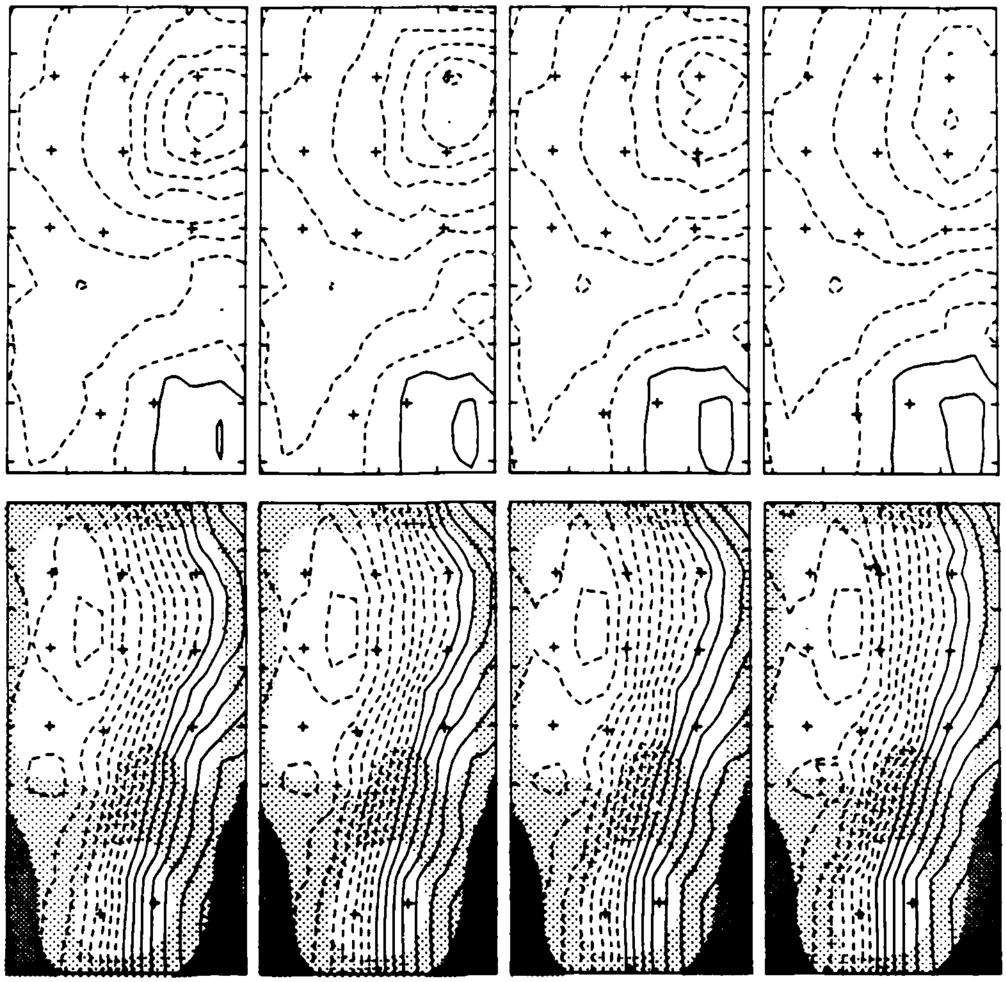
12 JUNE 1983

13 JUNE 1983

14 JUNE 1983


15 JUNE 1983
16 JUNE 1983
17 JUNE 1983
18 JUNE 1983


19 JUNE 1983
20 JUNE 1983
21 JUNE 1983
22 JUNE 1983

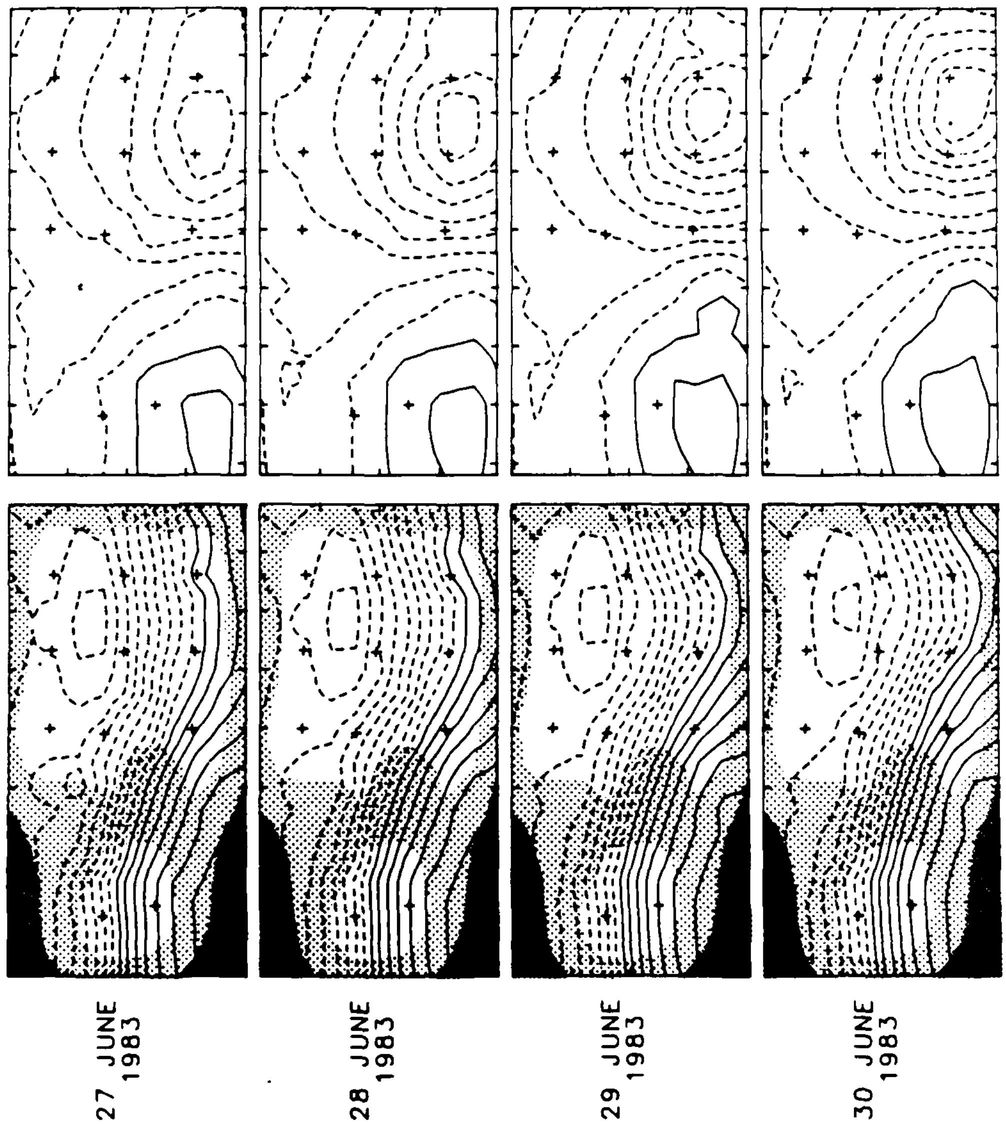


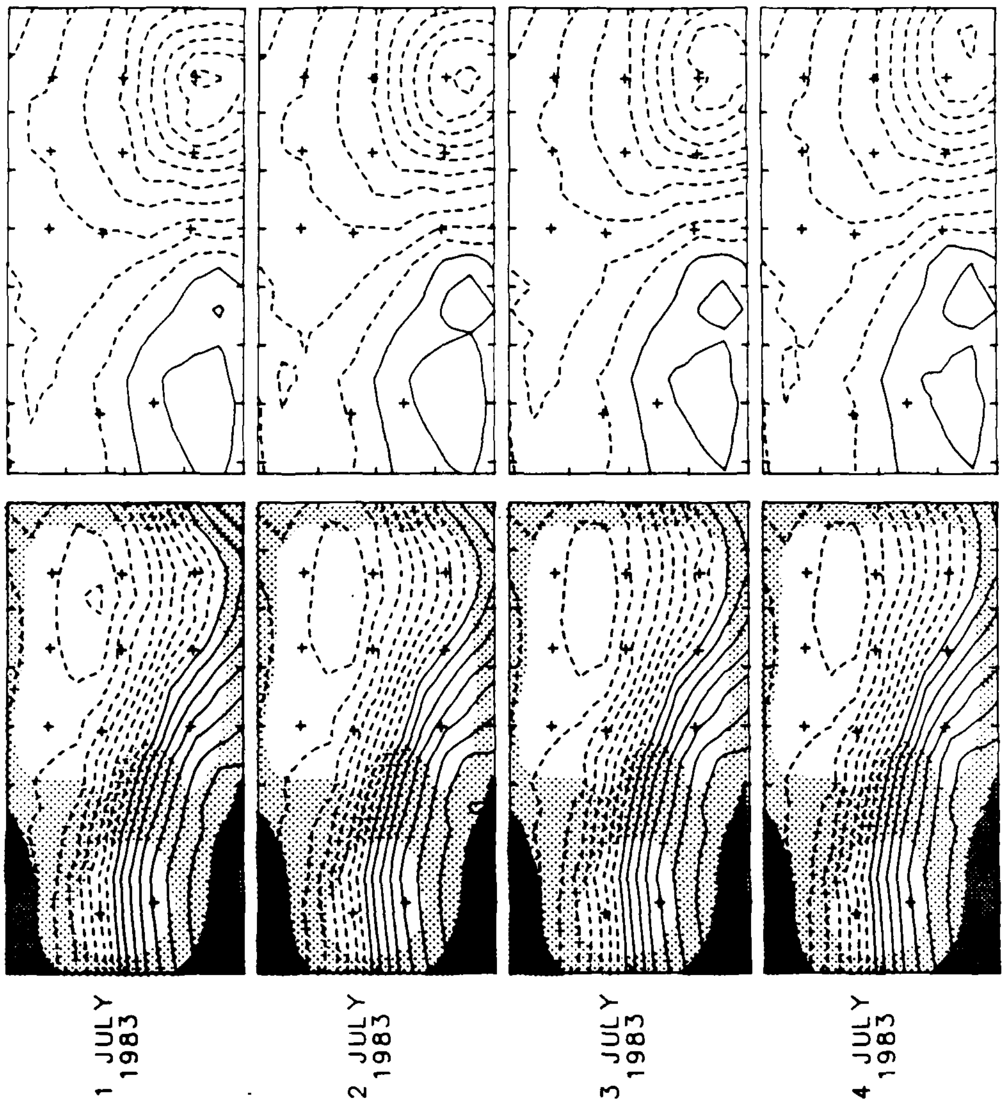
23 JUNE 1983

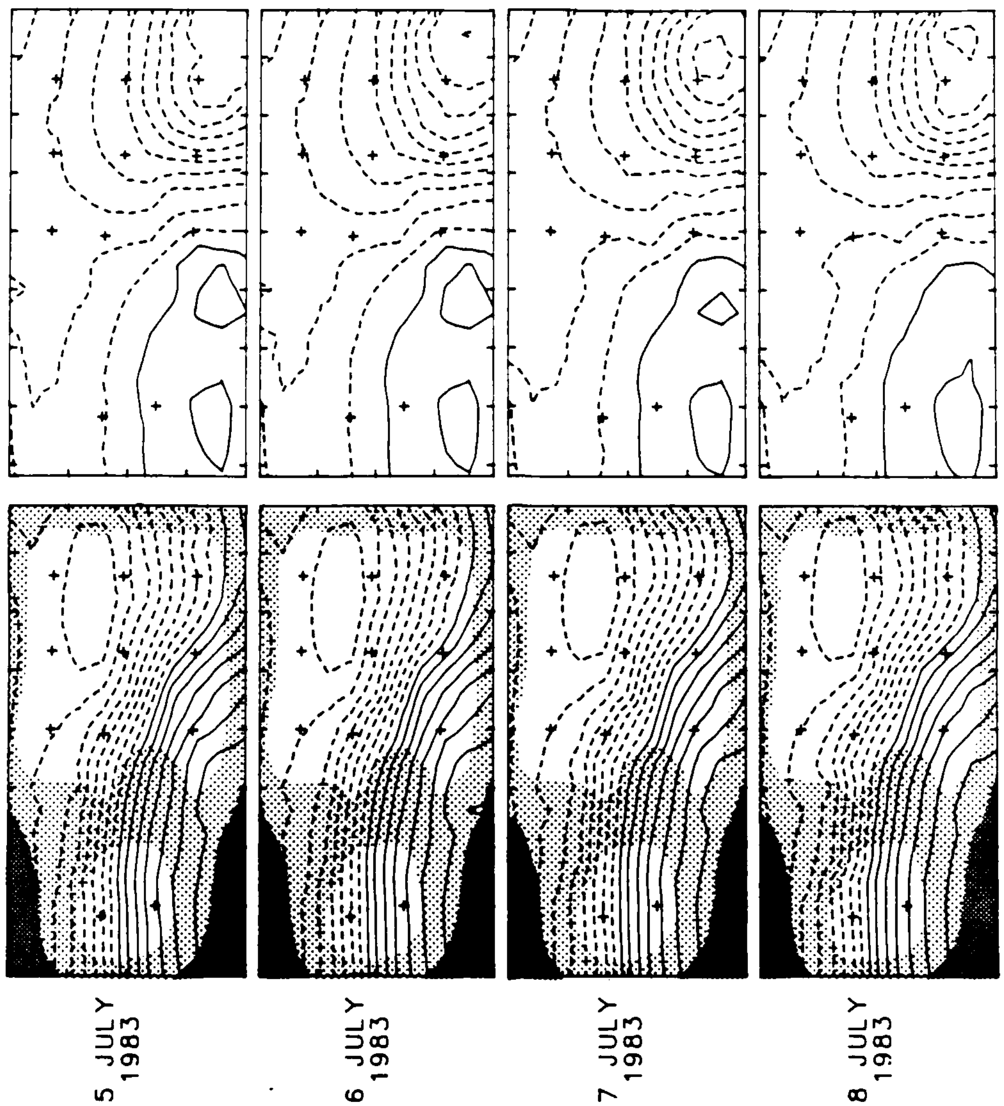
24 JUNE 1983

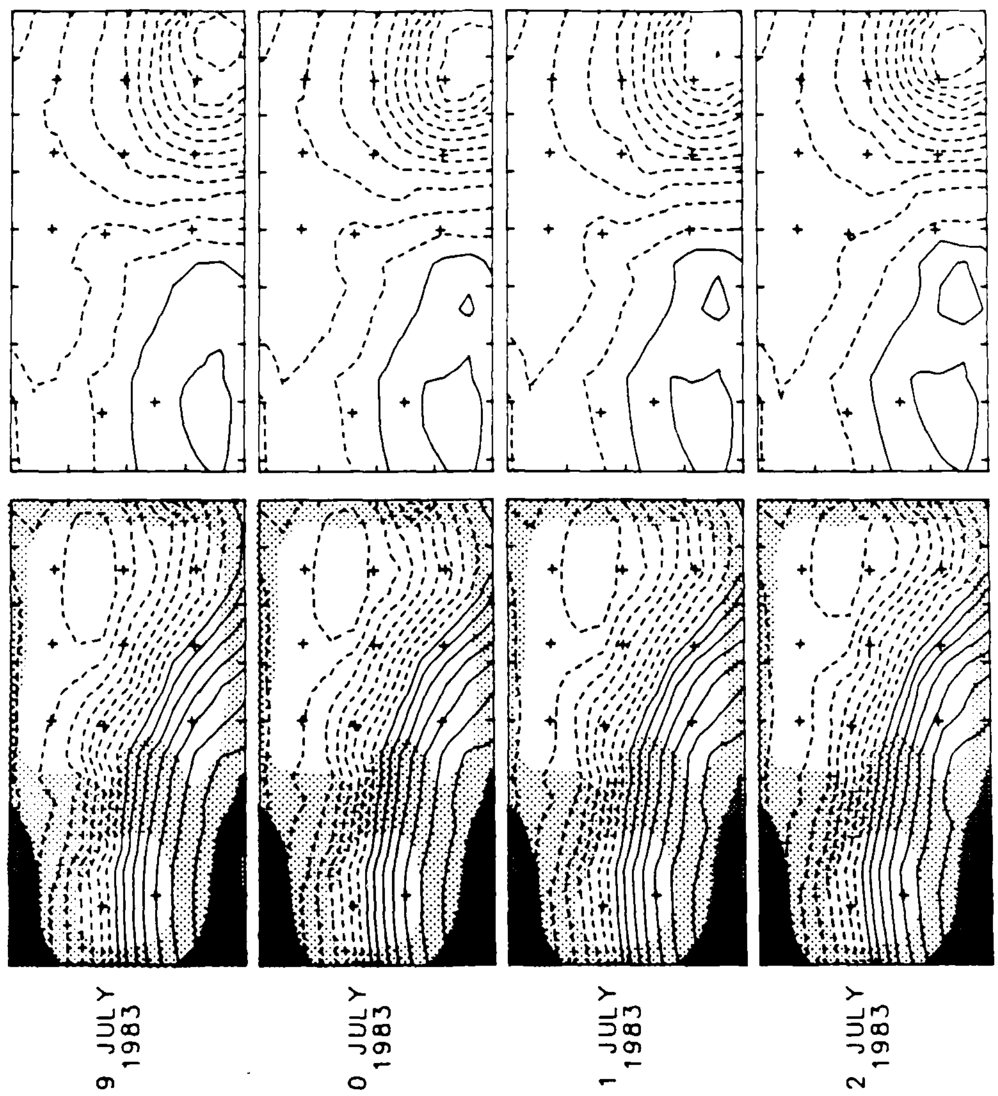
25 JUNE 1983

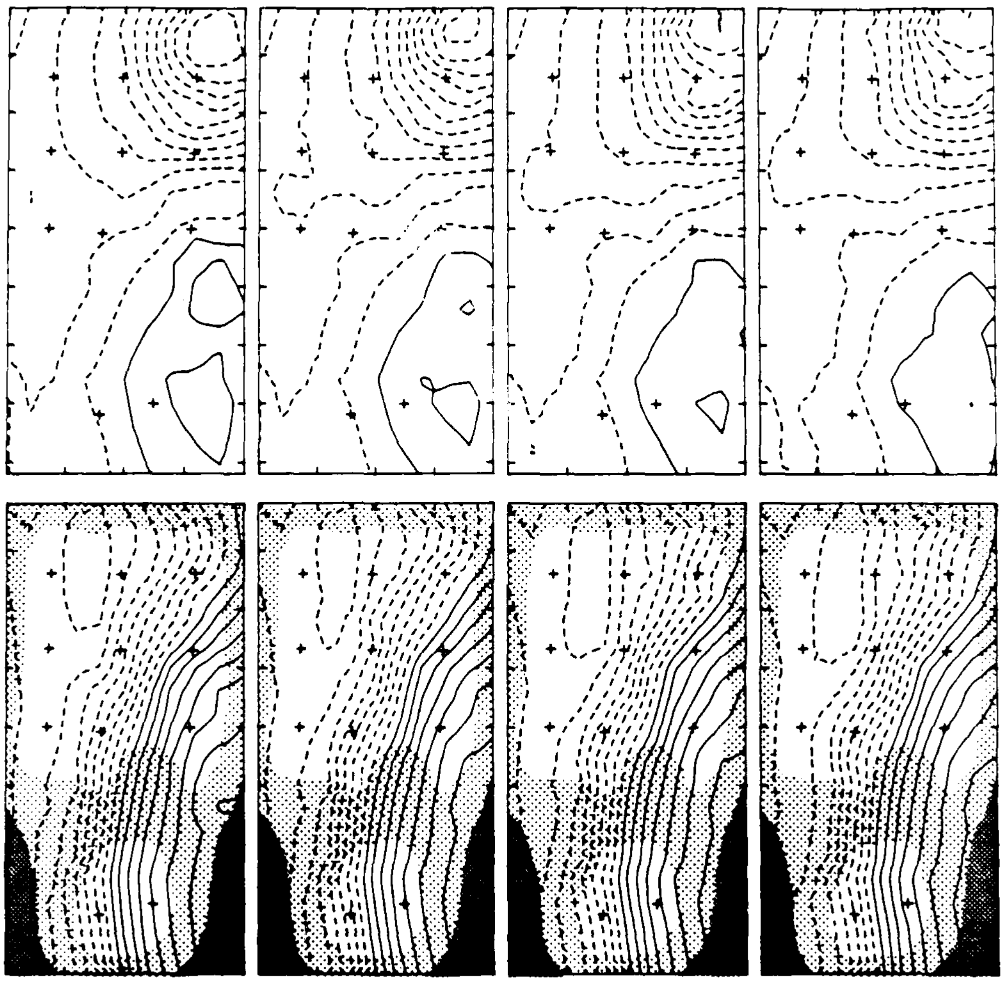
26 JUNE 1983


27 JUNE
1983
28 JUNE
1983
29 JUNE
1983
30 JUNE
1983


1 JULY 1983
2 JULY 1983
3 JULY 1983
4 JULY 1983


5 JULY 1983
6 JULY 1983
7 JULY 1983
8 JULY 1983


9 JULY
1983
10 JULY
1983
11 JULY
1983
12 JULY
1983

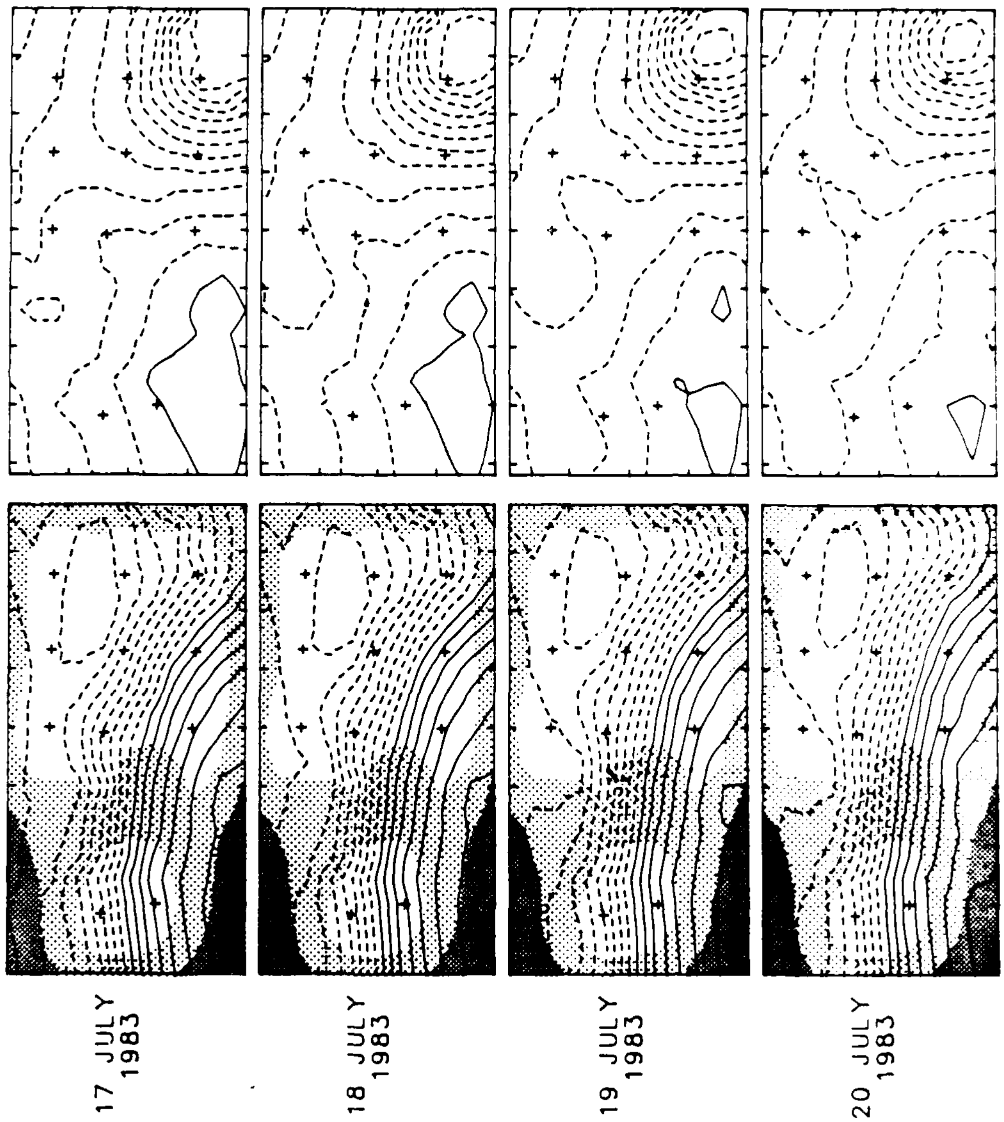


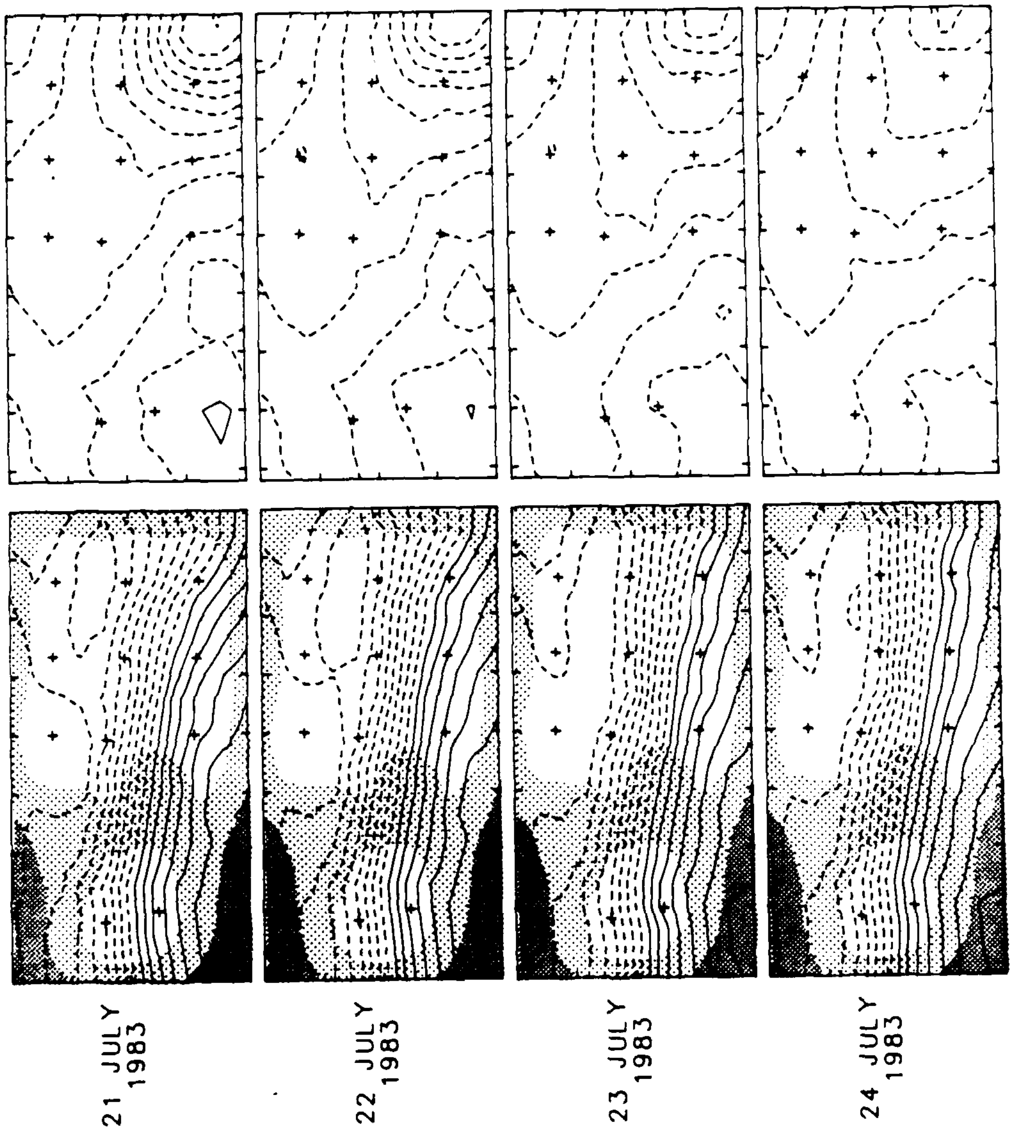
13 JULY 1983

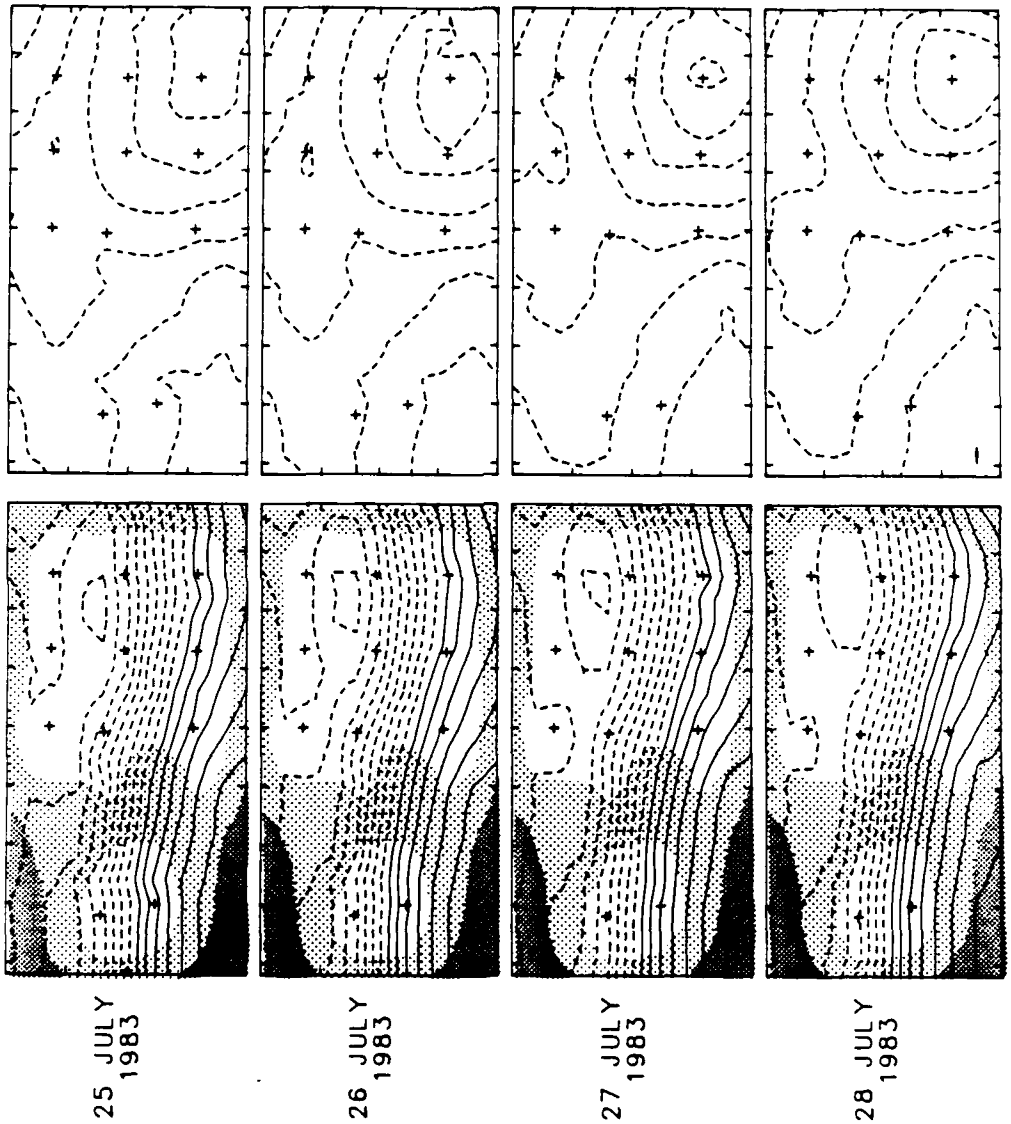
14 JULY 1983

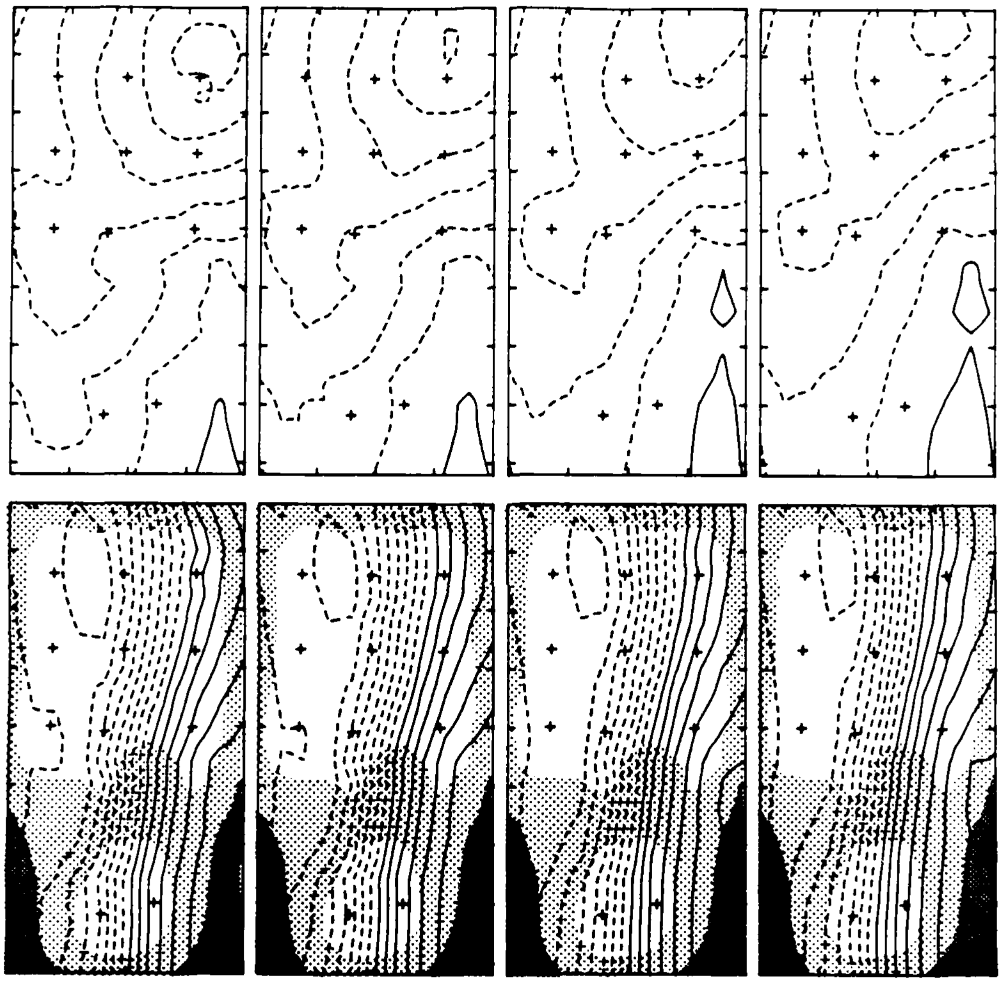
15 JULY 1983

16 JULY 1983


17 JULY 1983
18 JULY 1983
19 JULY 1983
20 JULY 1983


21 JULY 1983
22 JULY 1983
23 JULY 1983
24 JULY 1983


25 JULY 1983
26 JULY 1983
27 JULY 1983
28 JULY 1983

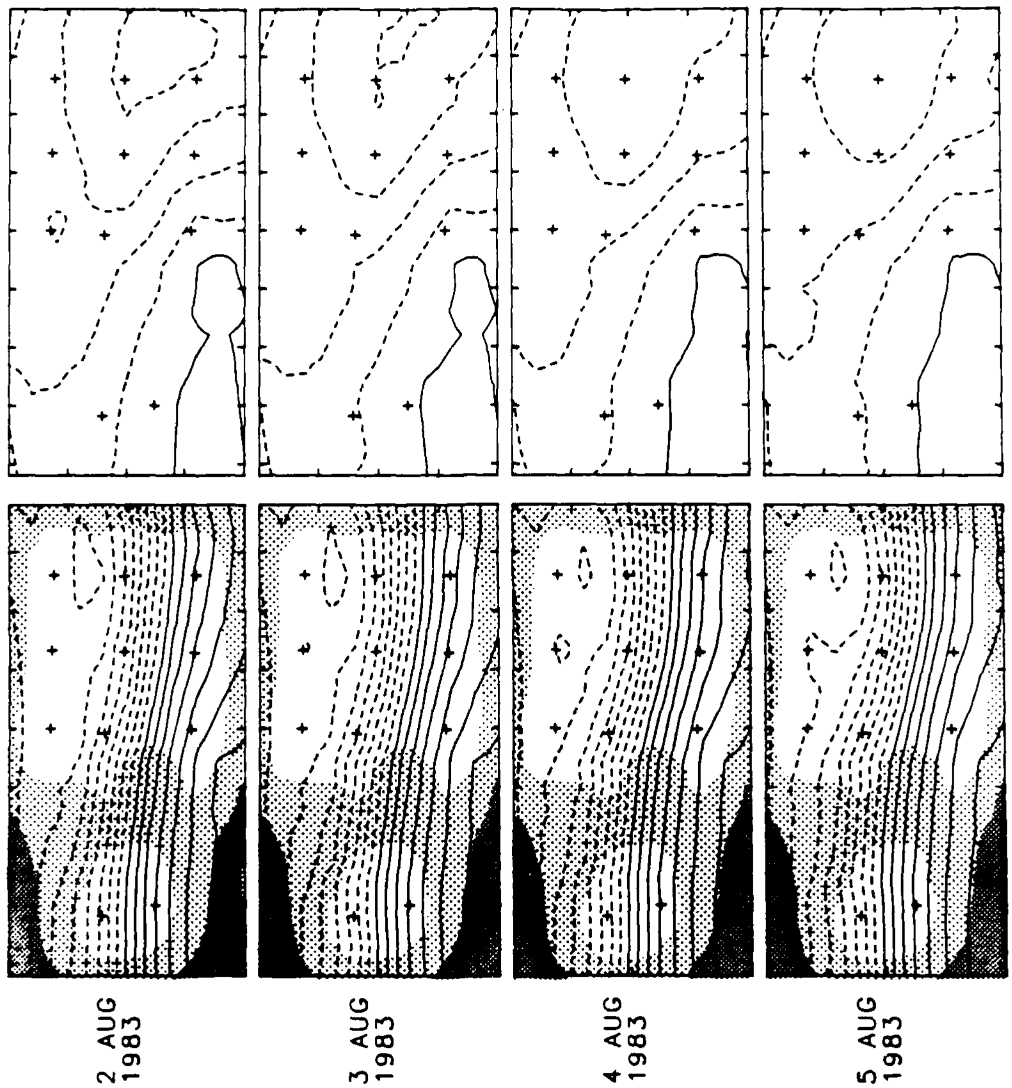


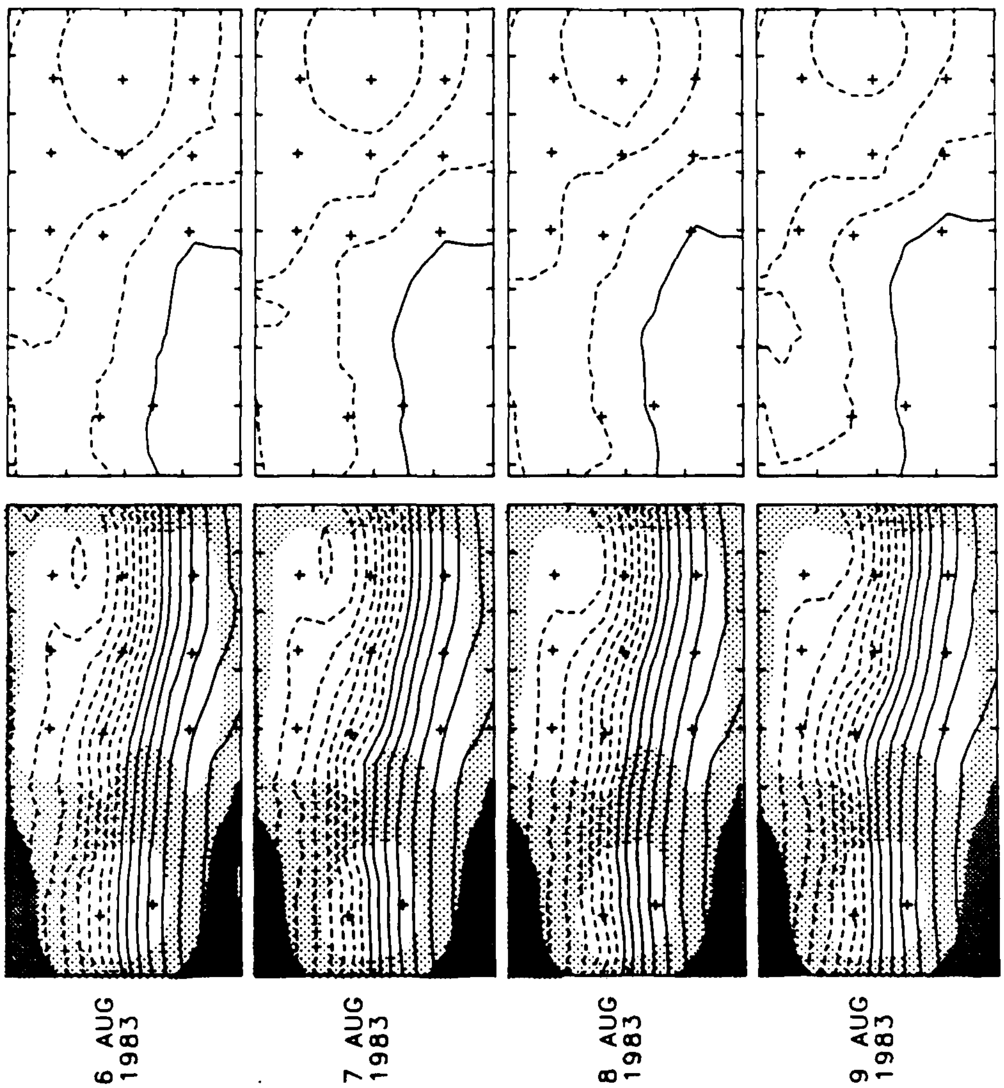
29 JULY 1983

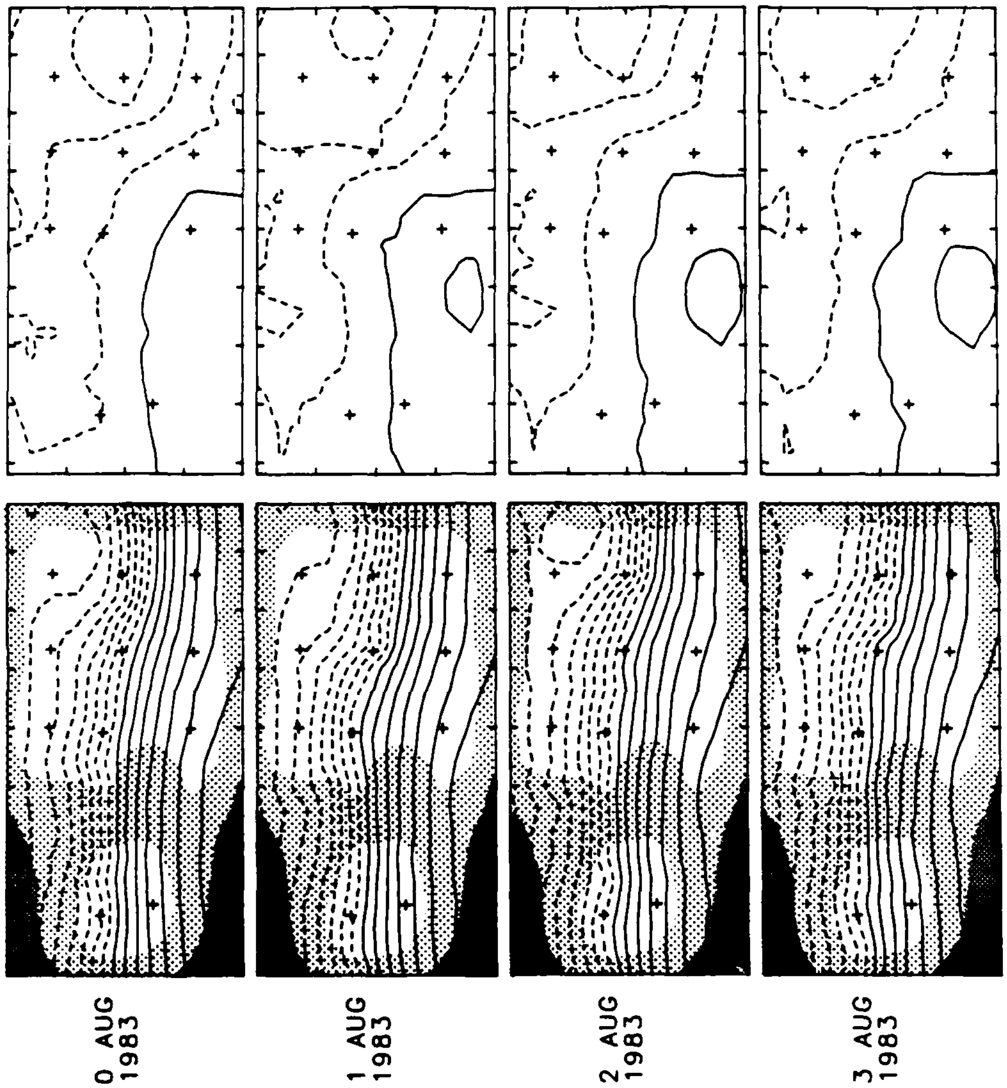
30 JULY 1983

31 JULY 1983

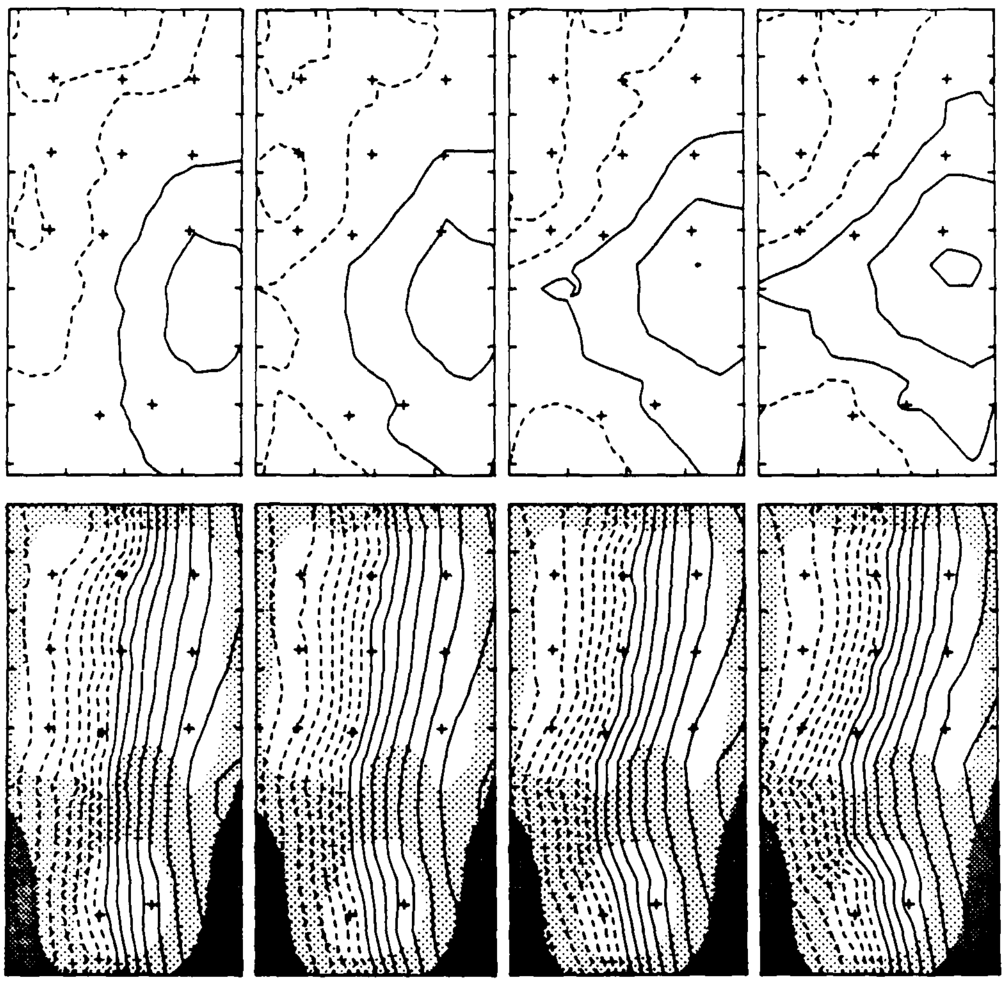
1 AUG 1983


2 AUG
1983
3 AUG
1983
4 AUG
1983
5 AUG
1983


6 AUG
1983
7 AUG
1983
8 AUG
1983
9 AUG
1983



10 AUG 1983
11 AUG 1983
12 AUG 1983
13 AUG 1983

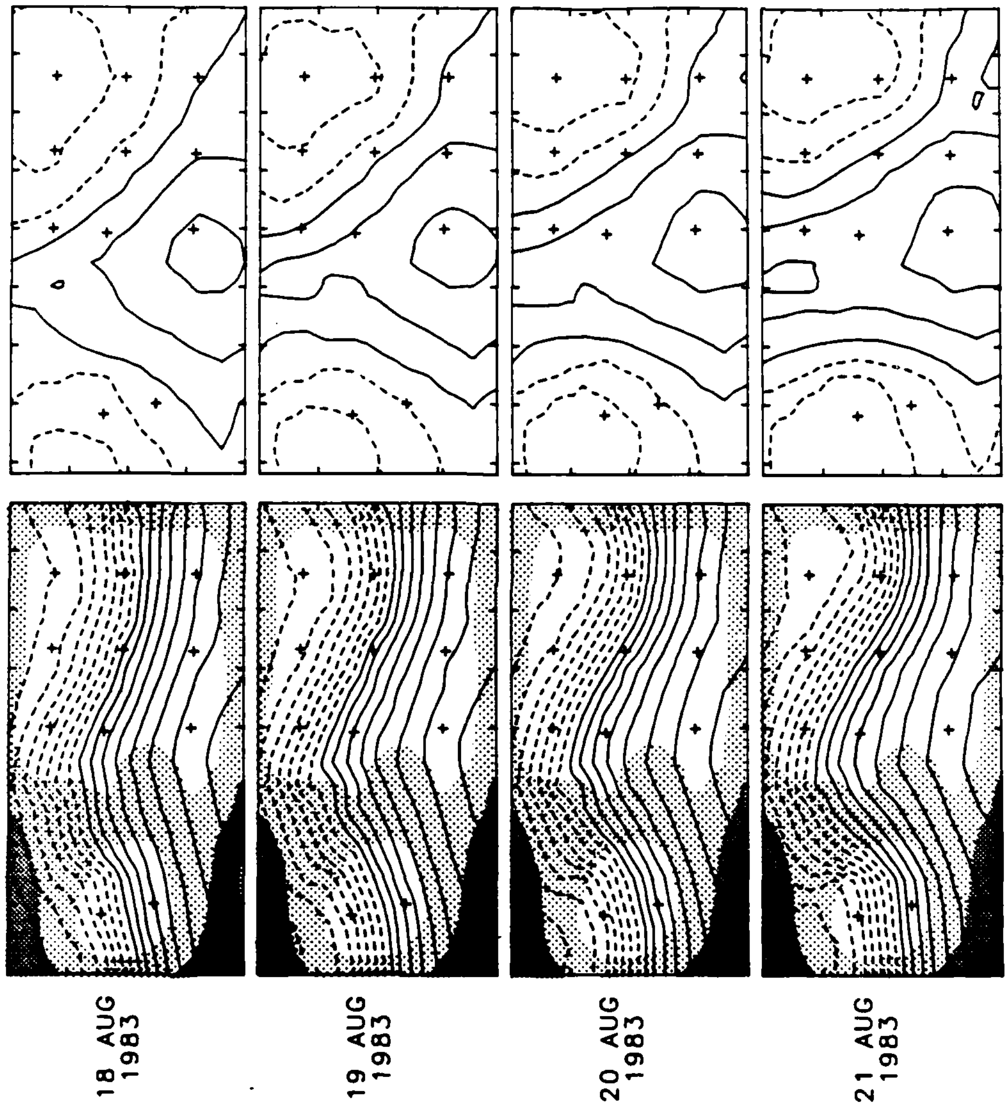


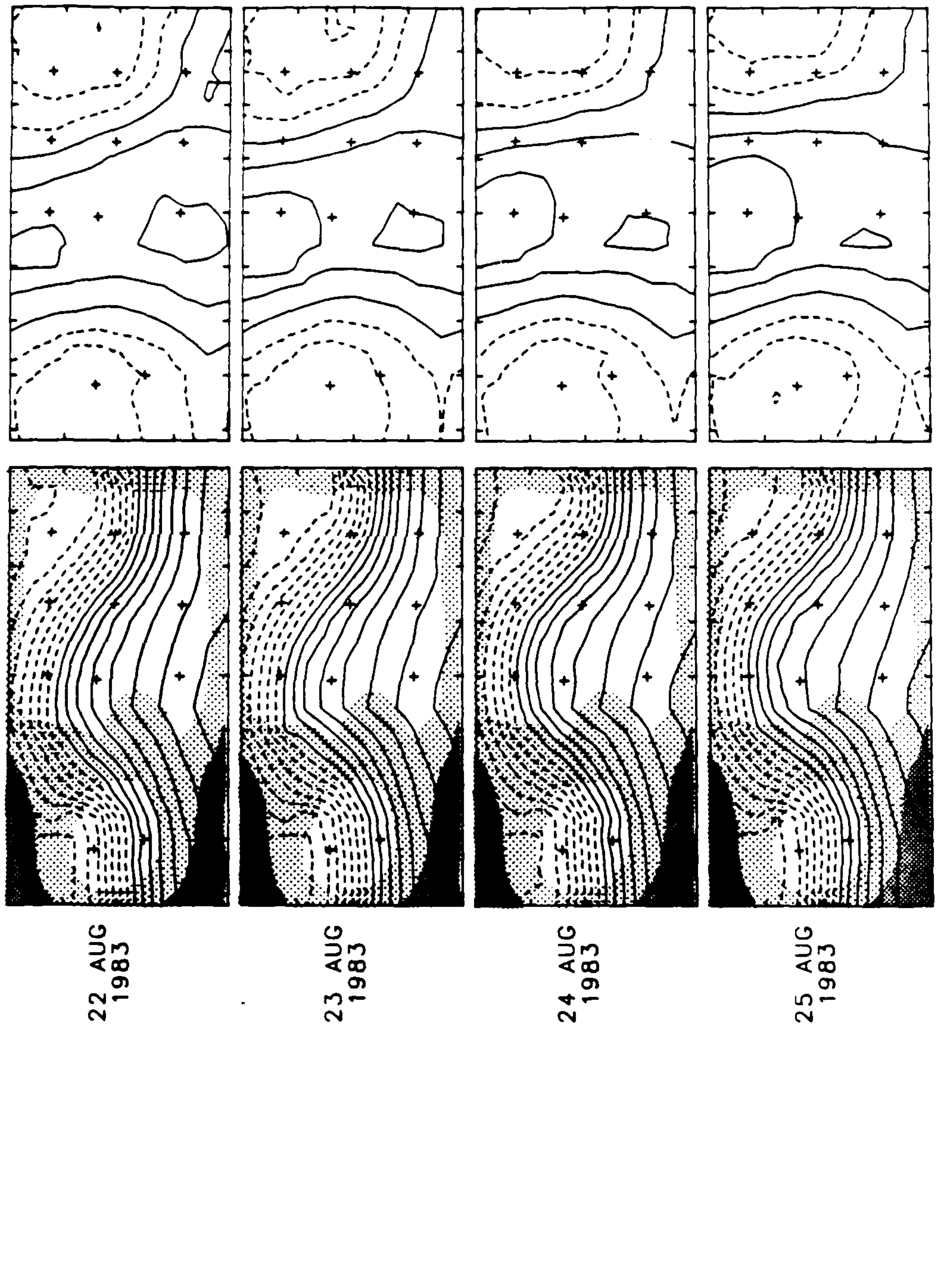
14 AUG 1983

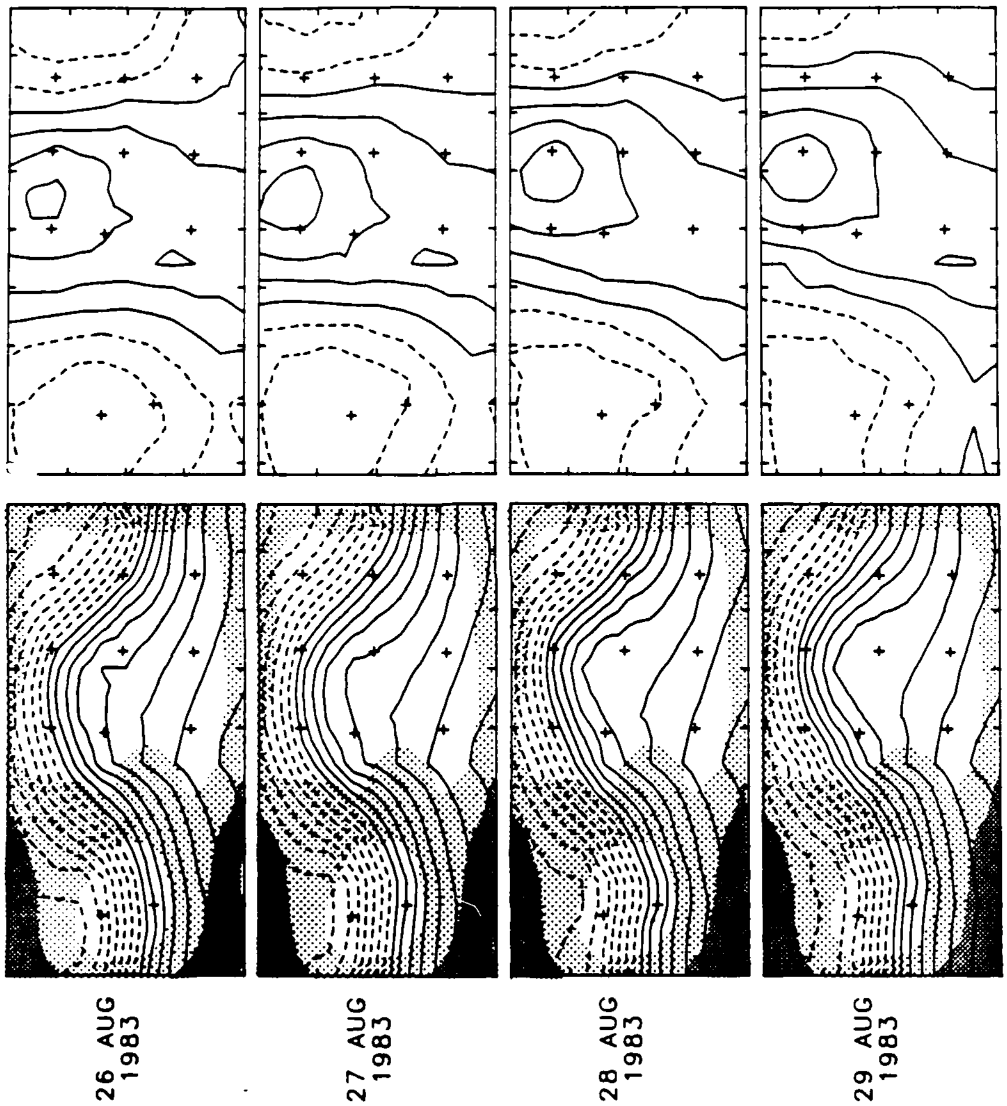
15 AUG 1983

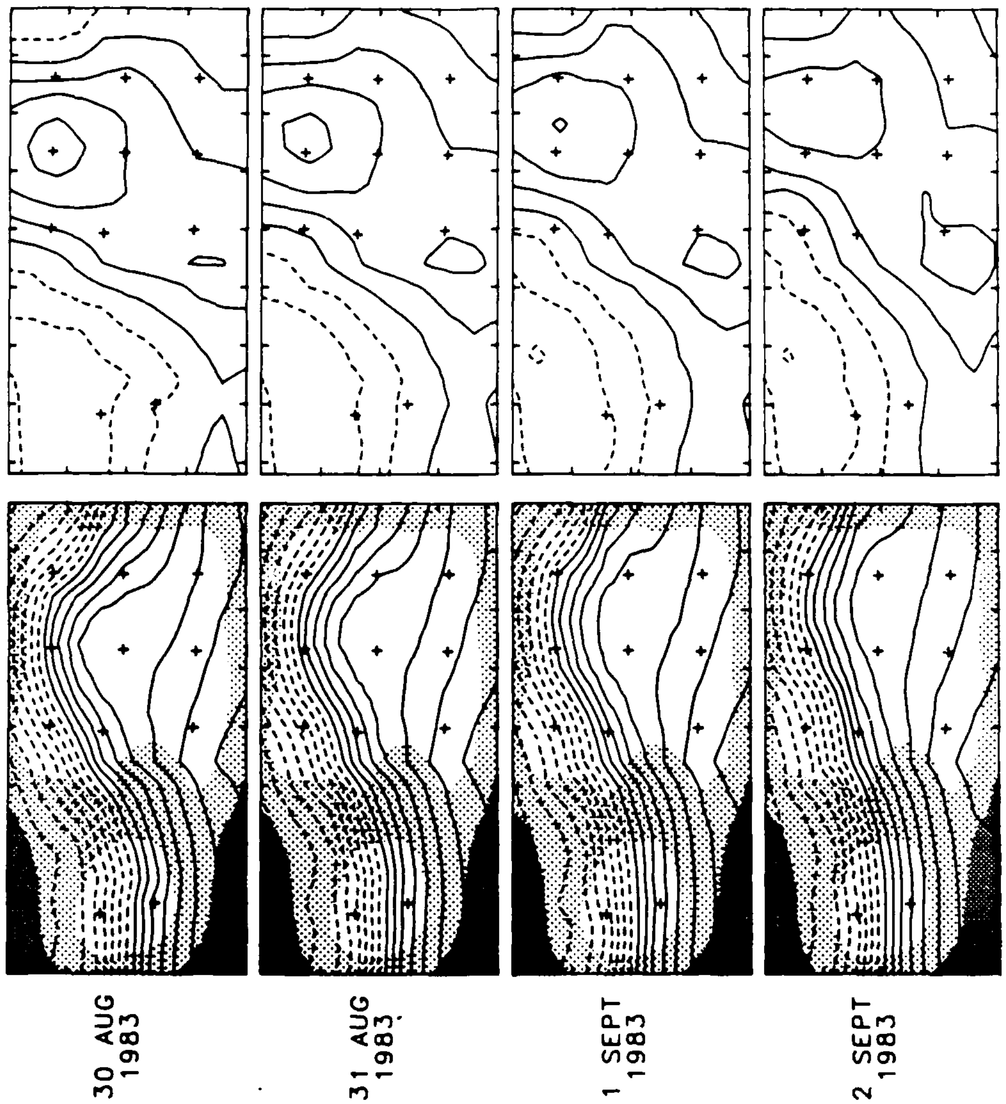
16 AUG 1983

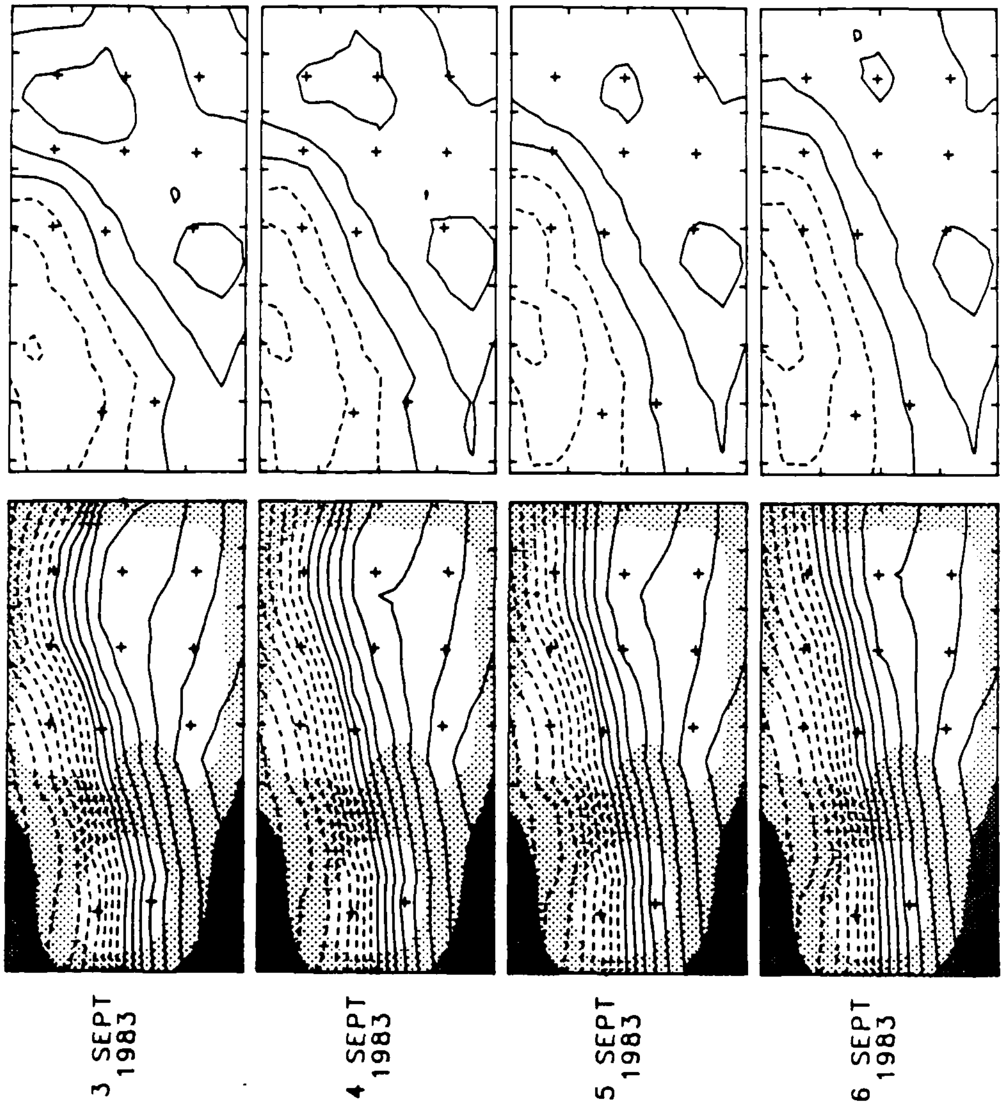
17 AUG 1983

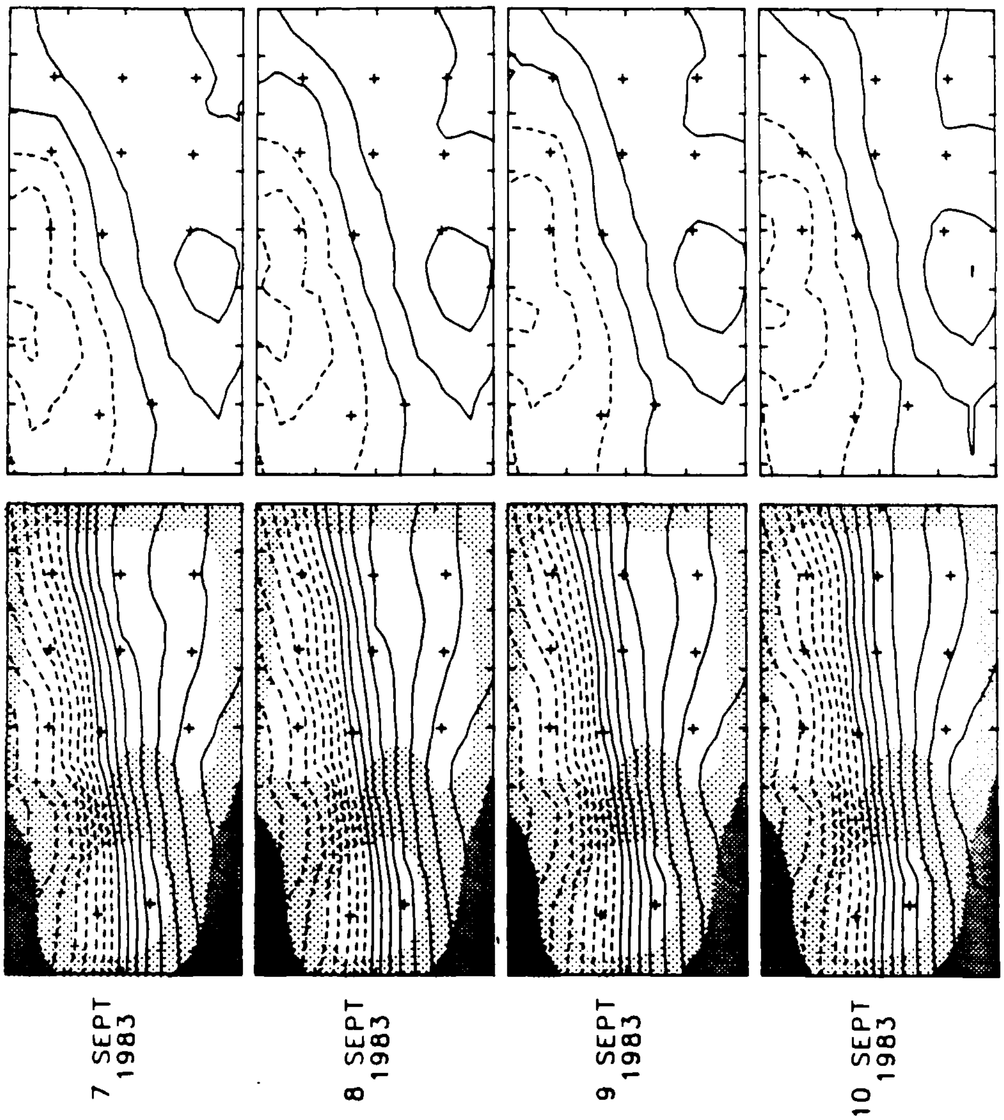

18 AUG 1983
19 AUG 1983
20 AUG 1983
21 AUG 1983

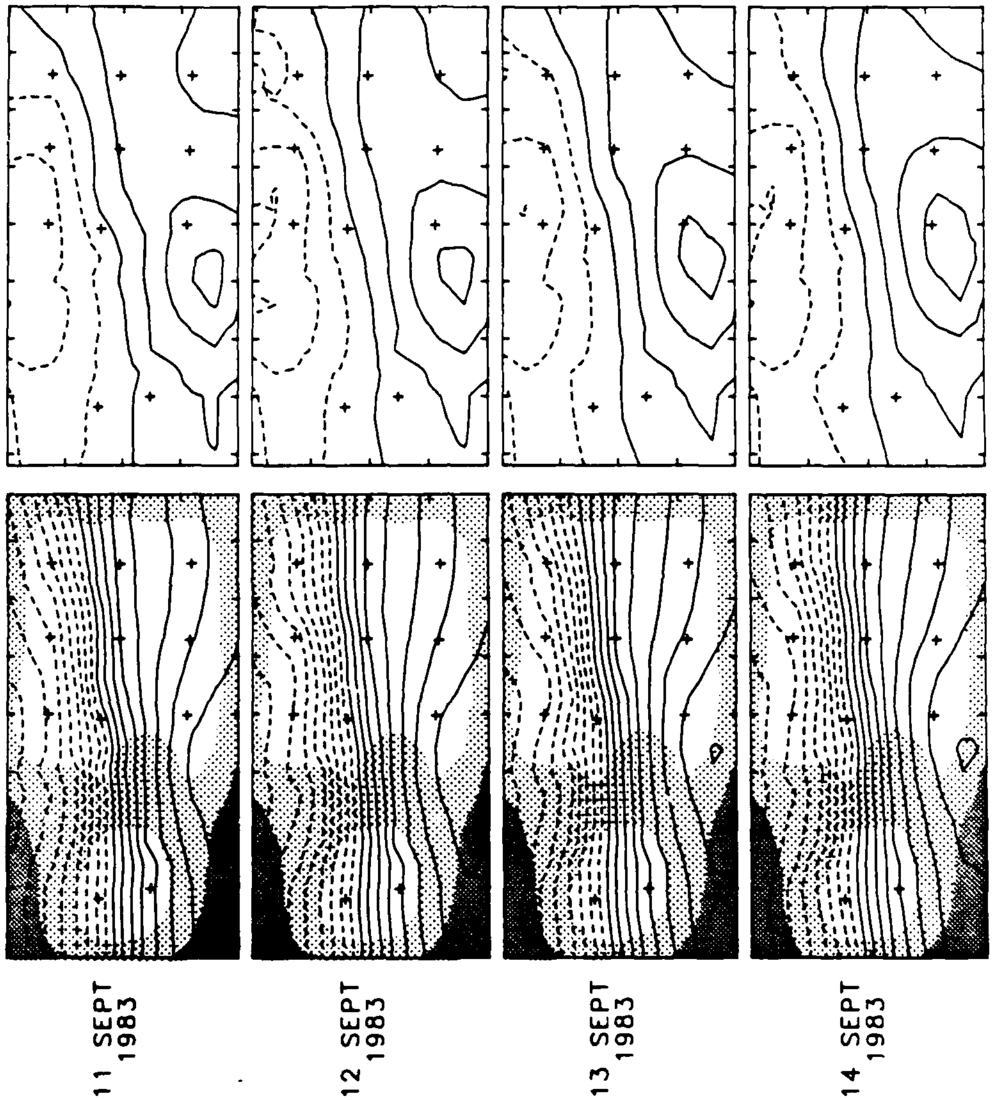

22 AUG 1983
23 AUG 1983
24 AUG 1983
25 AUG 1983

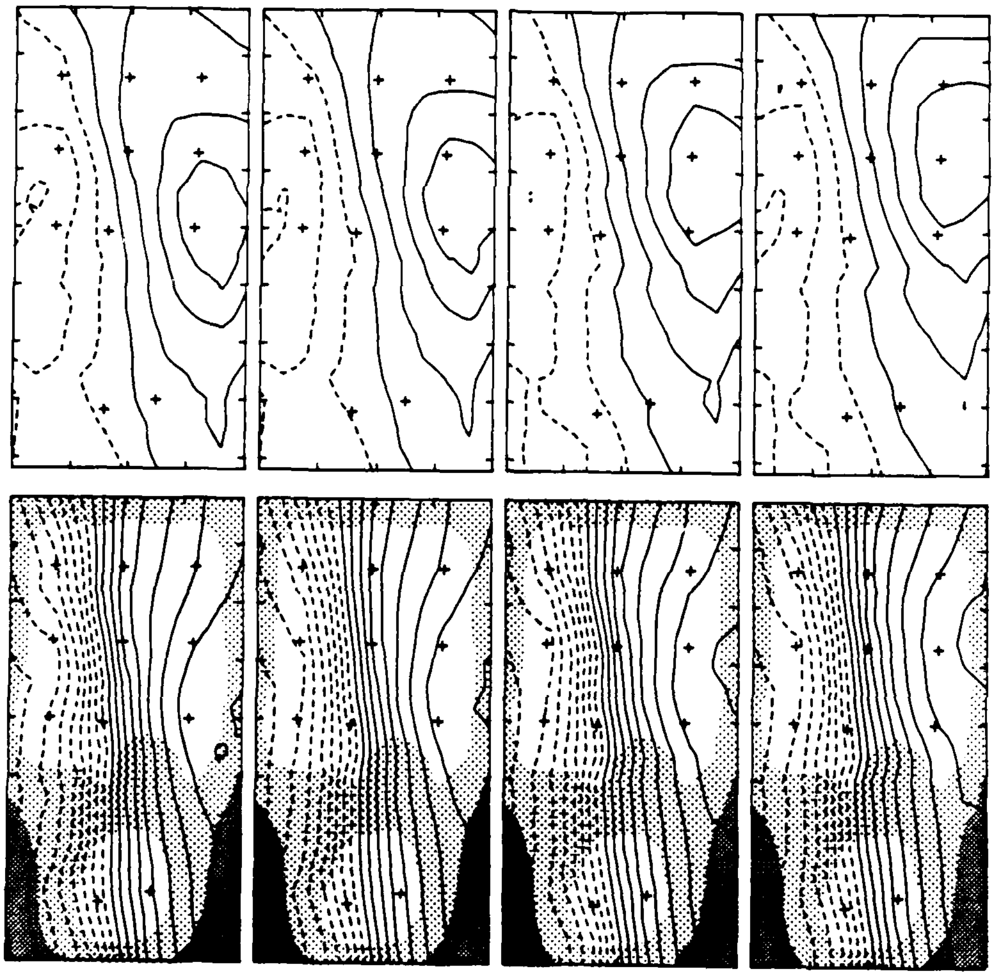

26 AUG 1983
27 AUG 1983
28 AUG 1983
29 AUG 1983


30 AUG
1983
31 AUG
1983
1 SEPT
1983
2 SEPT
1983


3 SEPT 1983
4 SEPT 1983
5 SEPT 1983
6 SEPT 1983


7 SEPT 1983
8 SEPT 1983
9 SEPT 1983
10 SEPT 1983


11 SEPT 1983
12 SEPT 1983
13 SEPT 1983
14 SEPT 1983

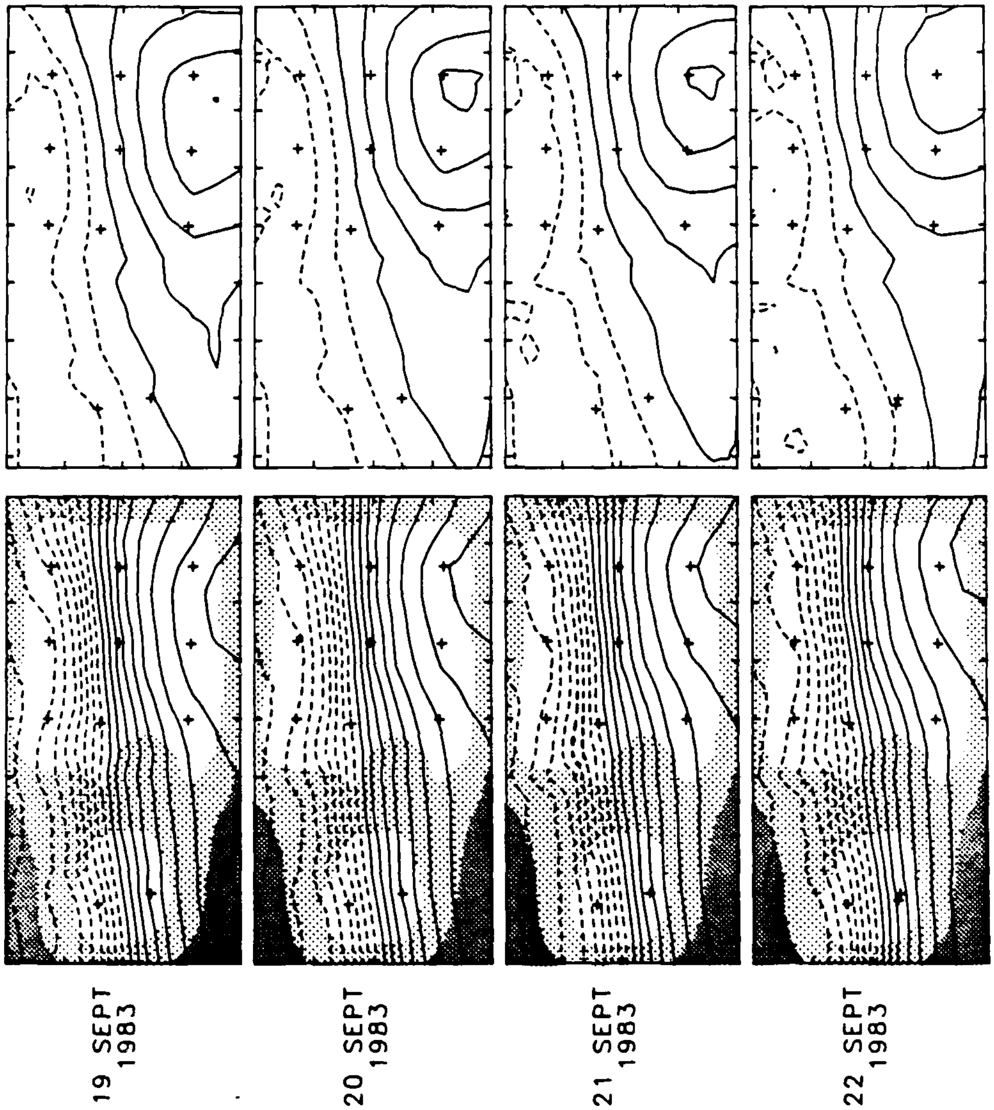


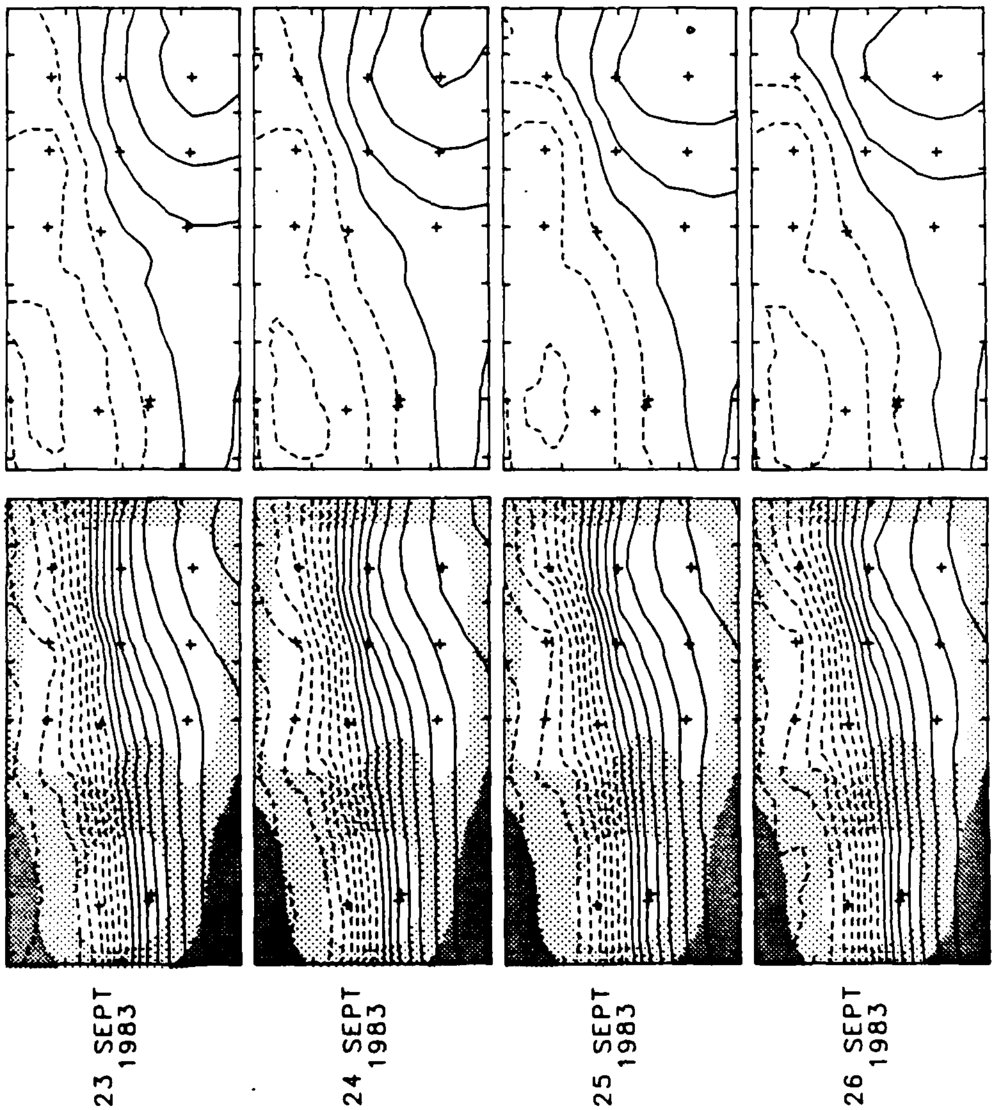
15 SEPT 1983

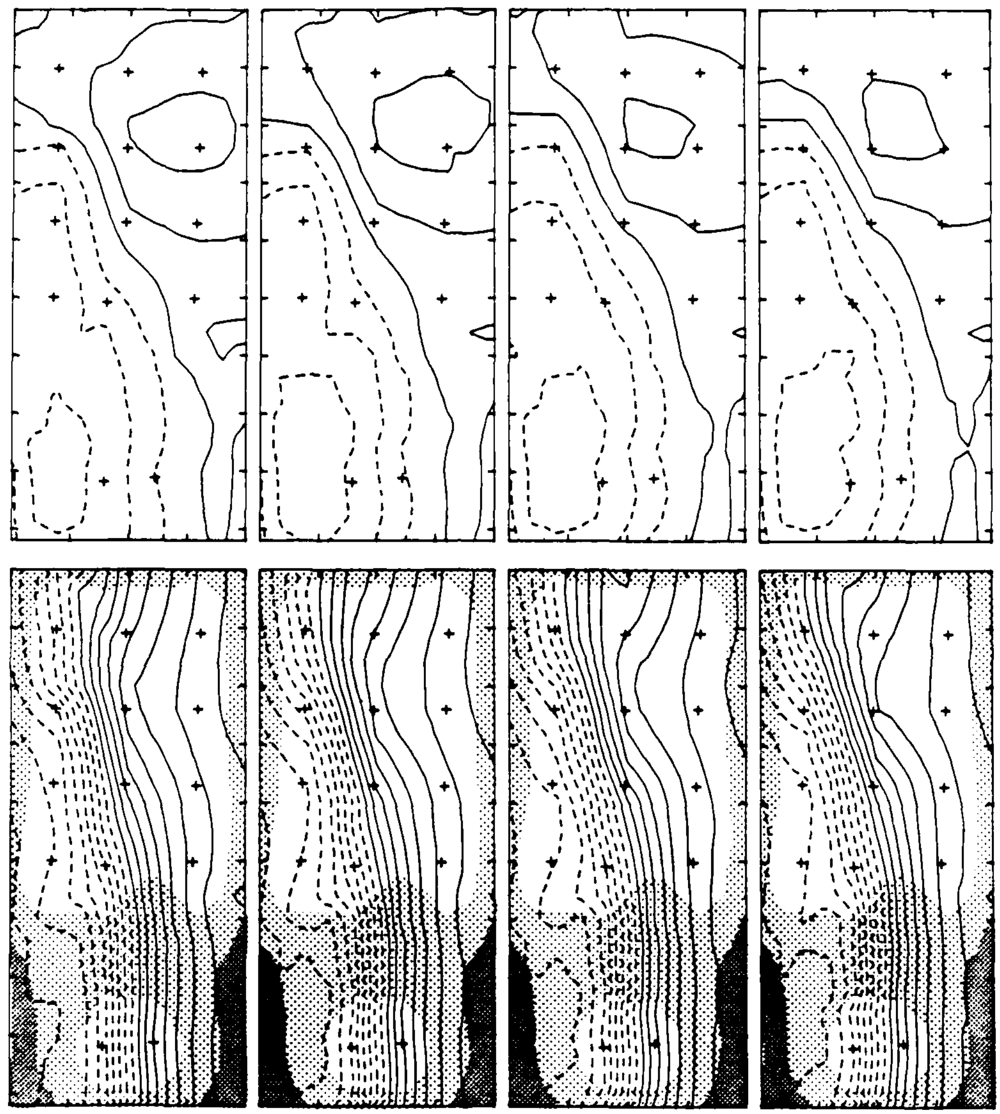
16 SEPT 1983

17 SEPT 1983

18 SEPT 1983


19 SEPT 1983
20 SEPT 1983
21 SEPT 1983
22 SEPT 1983


23 SEPT 1983
24 SEPT 1983
25 SEPT 1983
26 SEPT 1983

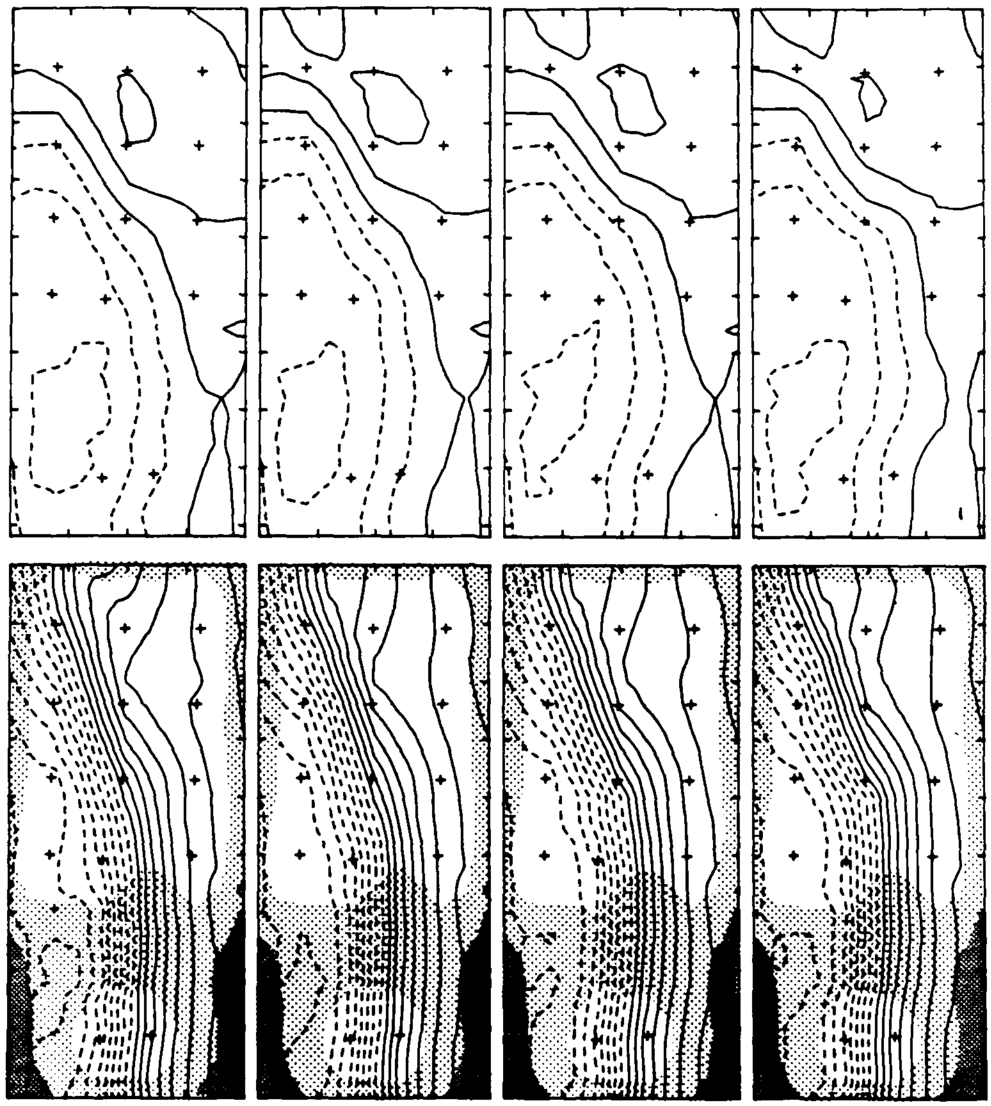


27 SEPT 1983

28 SEPT 1983

29 SEPT 1983

30 SEPT 1983

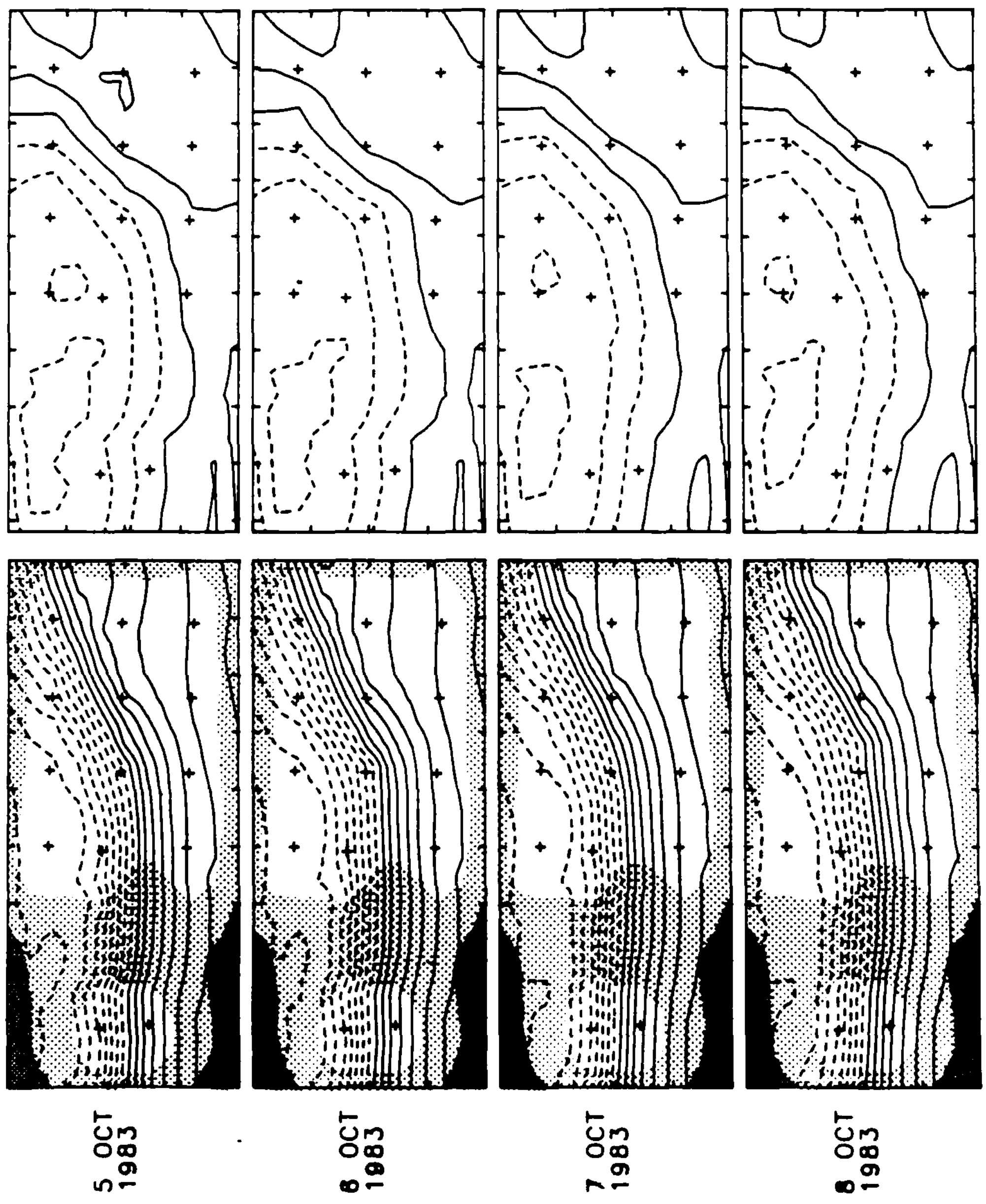


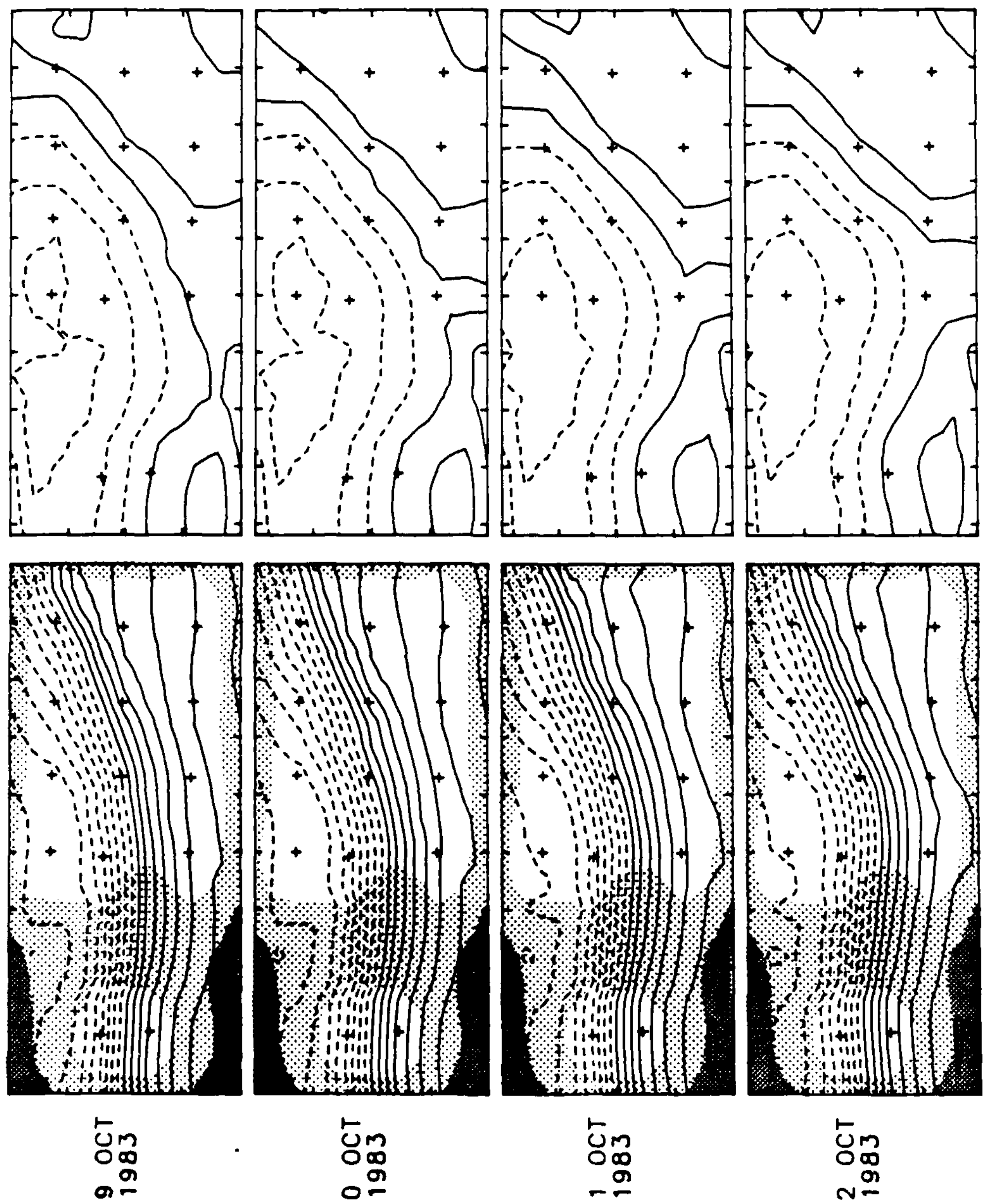
1 OCT 1983

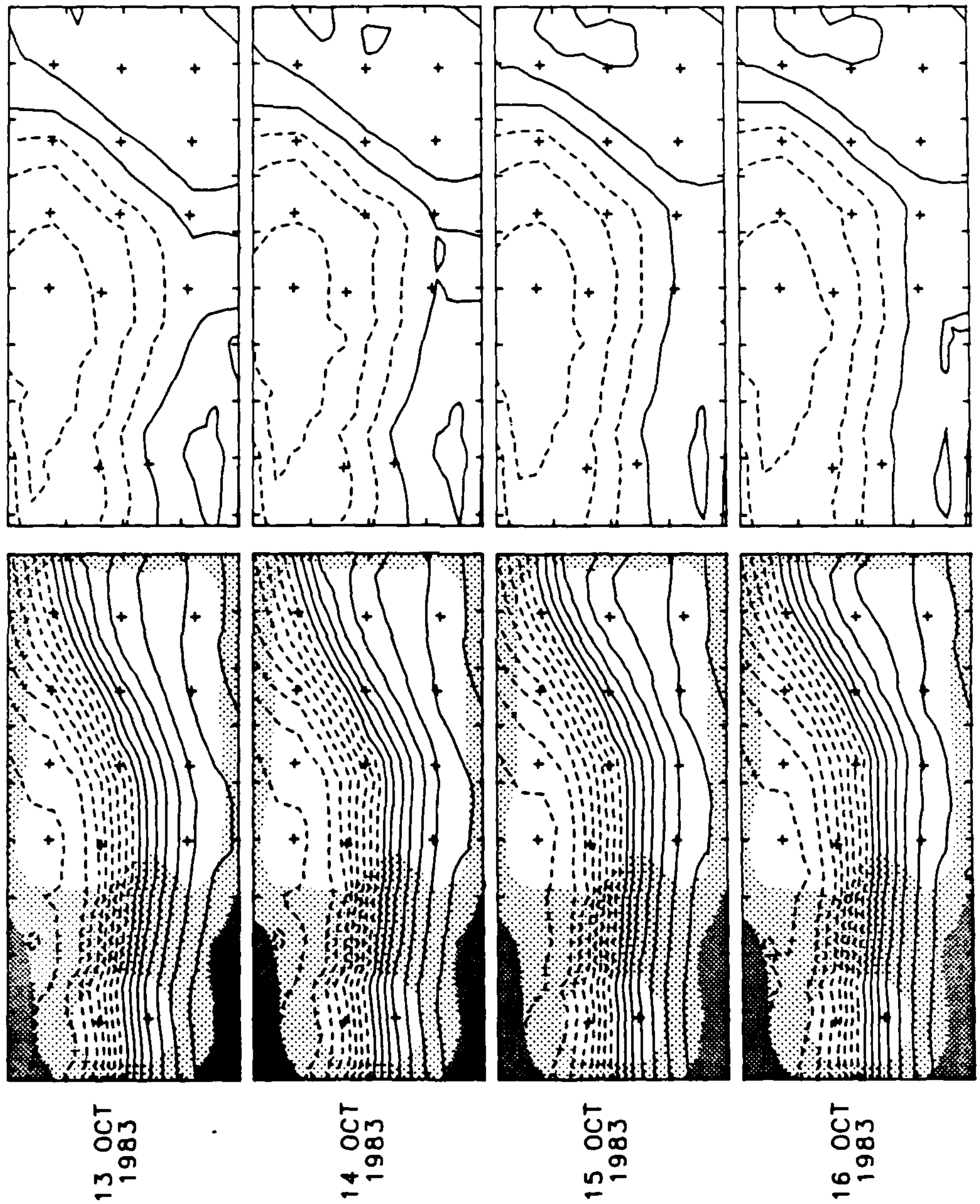
2 OCT 1983

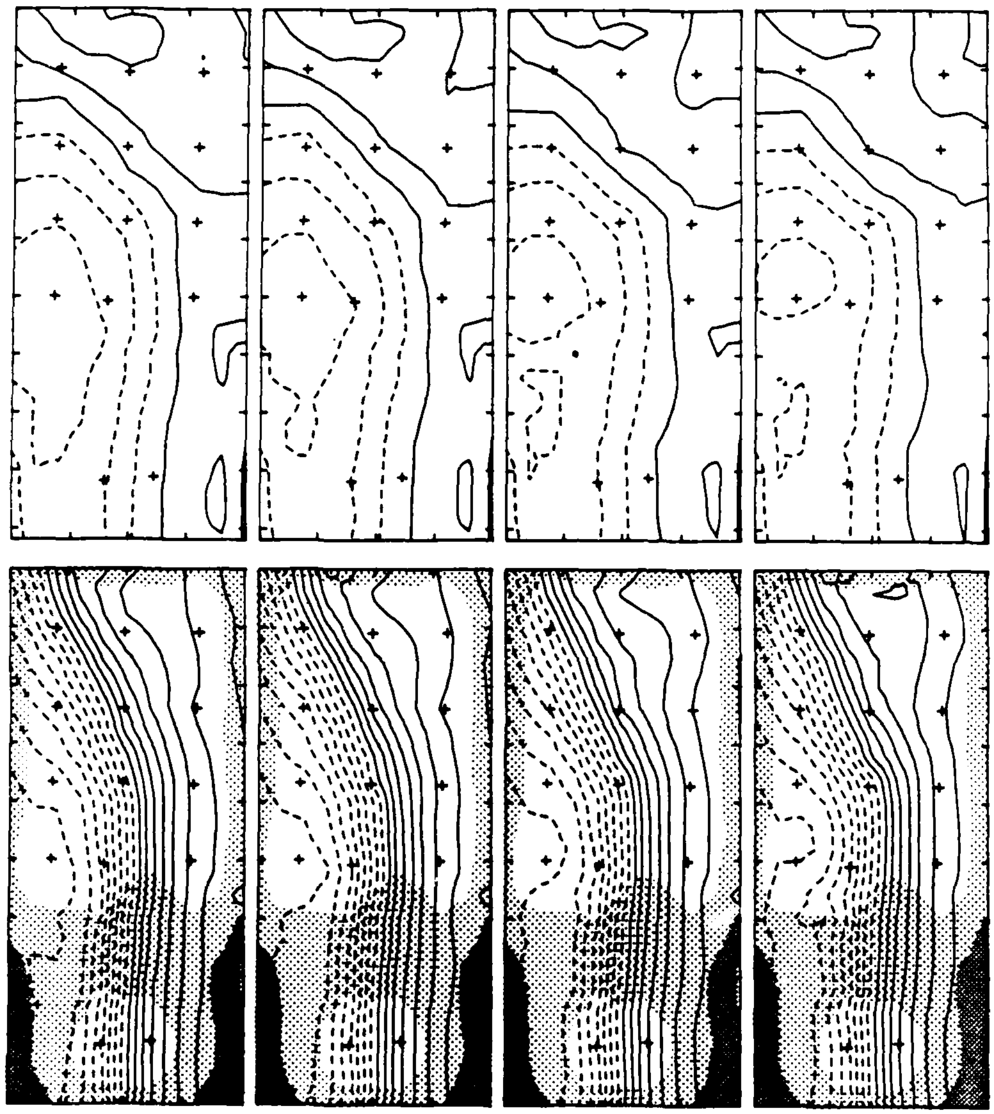
3 OCT 1983

4 OCT 1983


5 OCT
1983
6 OCT
1983
7 OCT
1983
8 OCT
1983


9 OCT 1983
10 OCT 1983
11 OCT 1983
12 OCT 1983


13 OCT 1983
14 OCT 1983
15 OCT 1983
16 OCT 1983

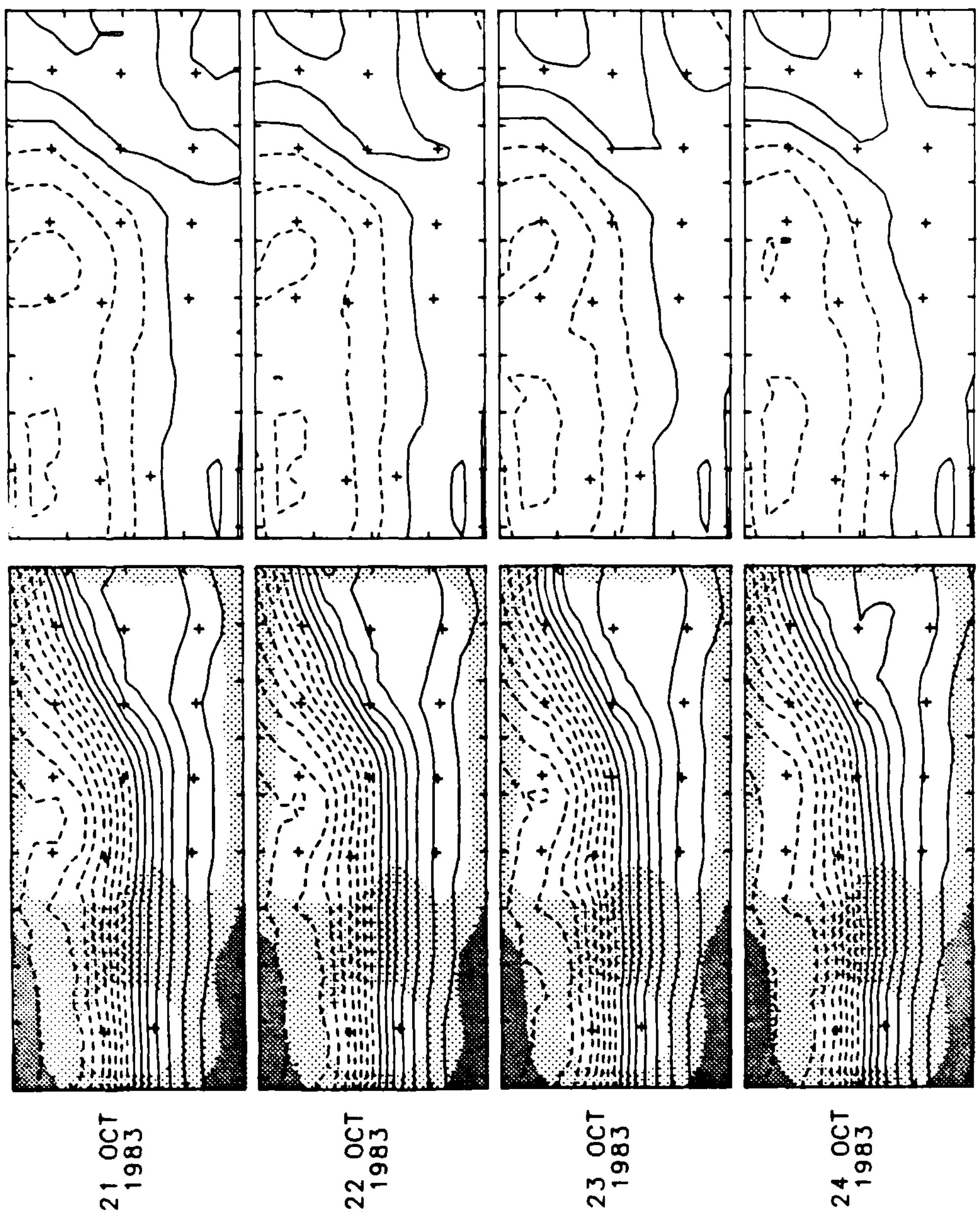


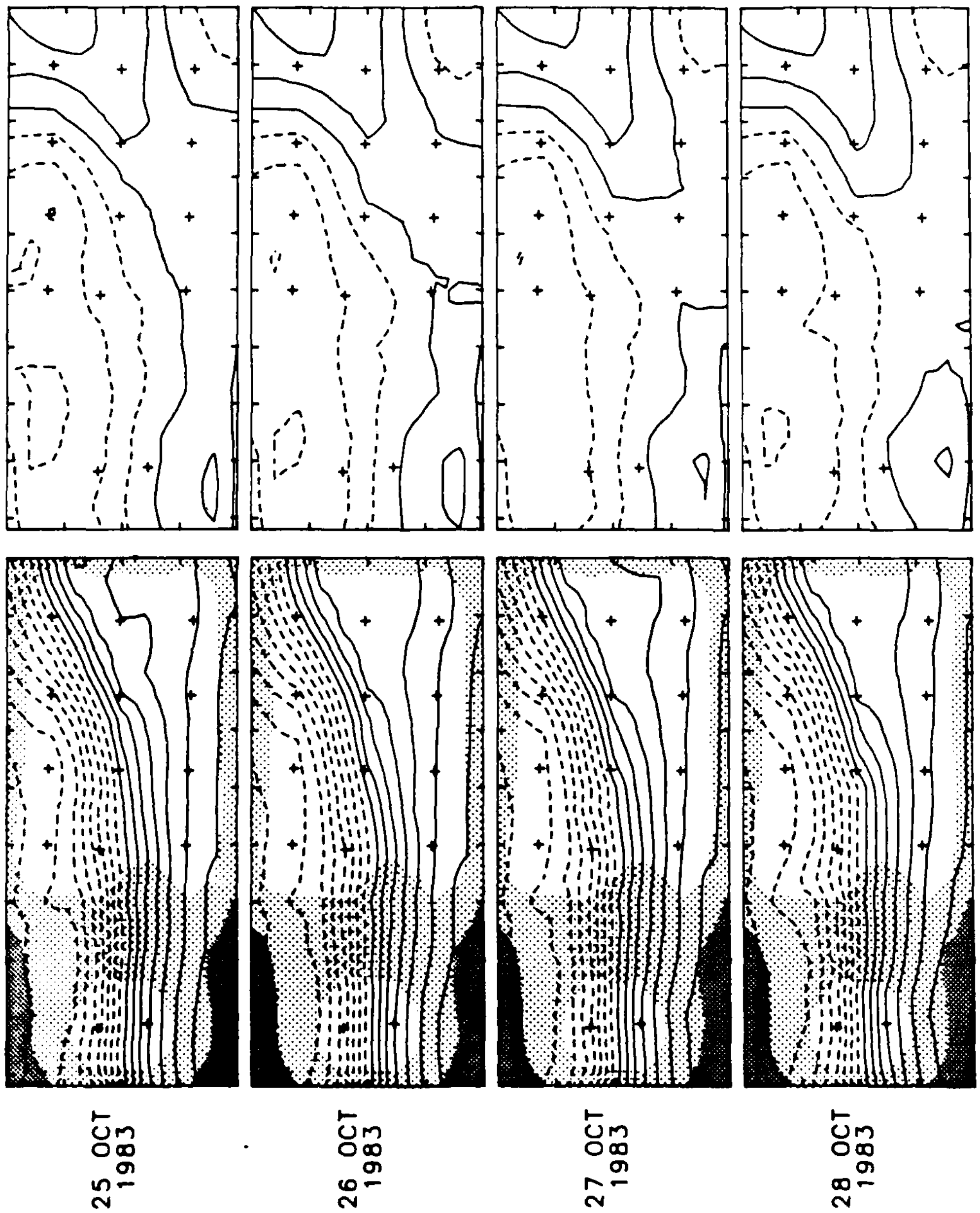
17 OCT 1983

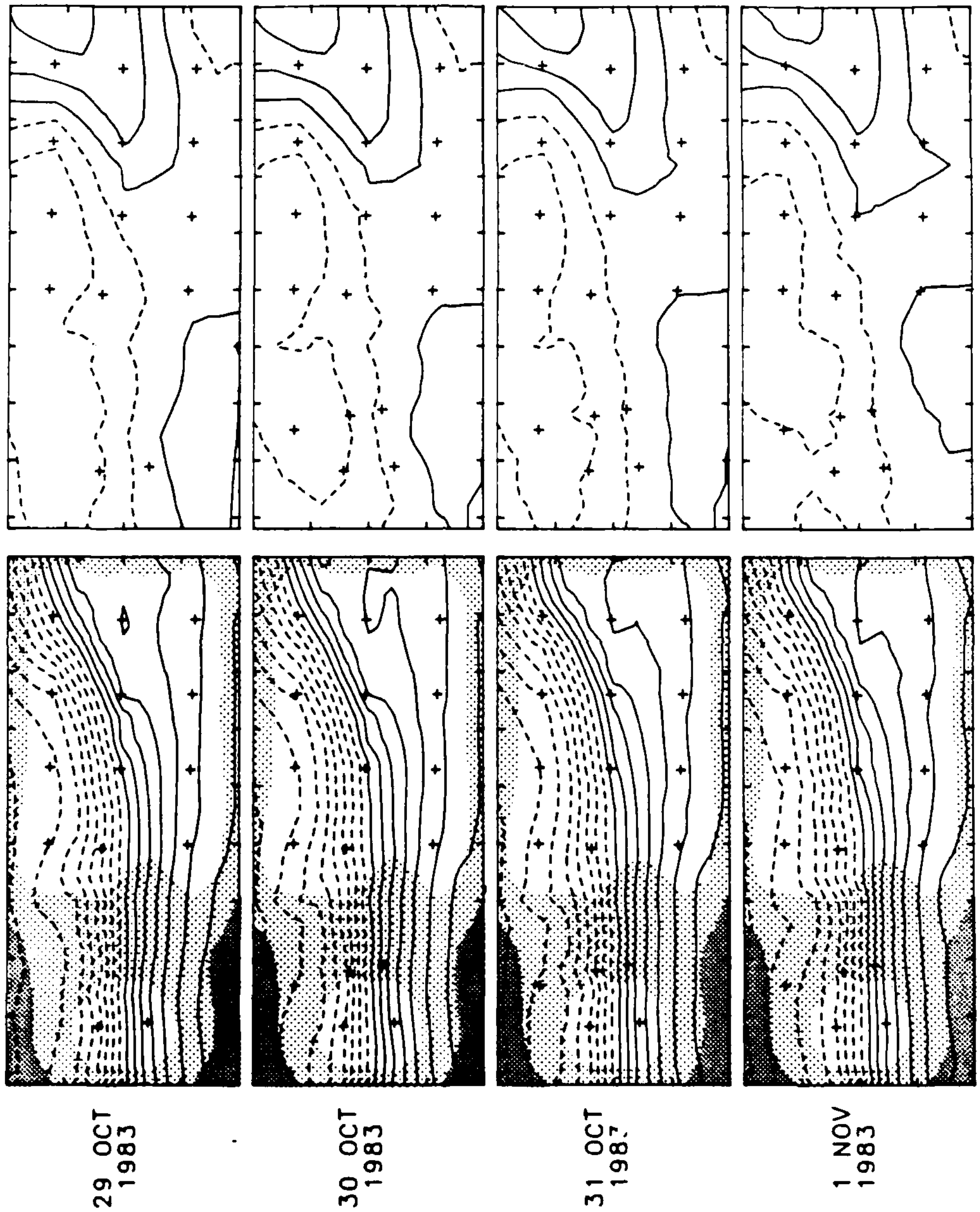
18 OCT 1983

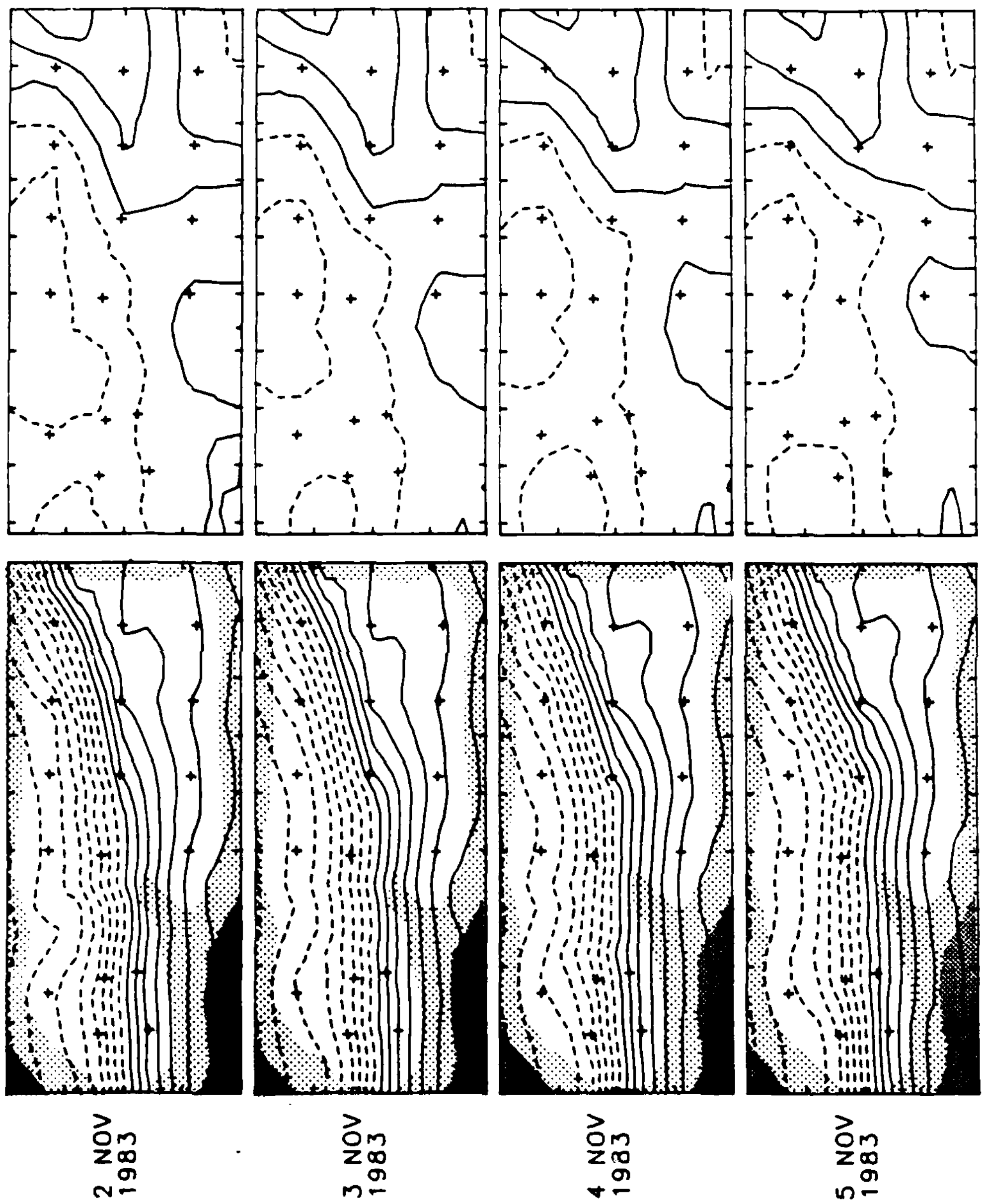
19 OCT 1983

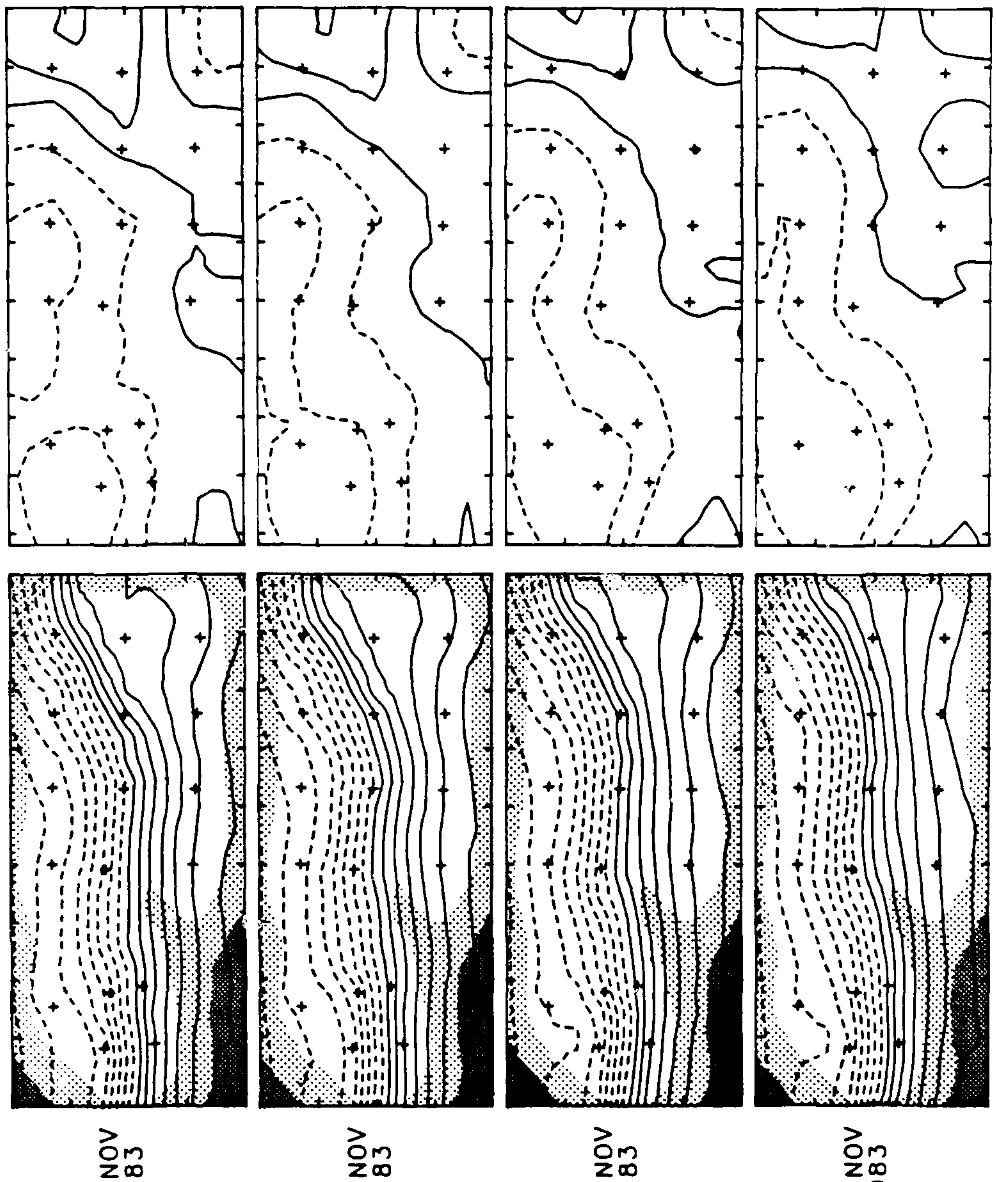
20 OCT 1983

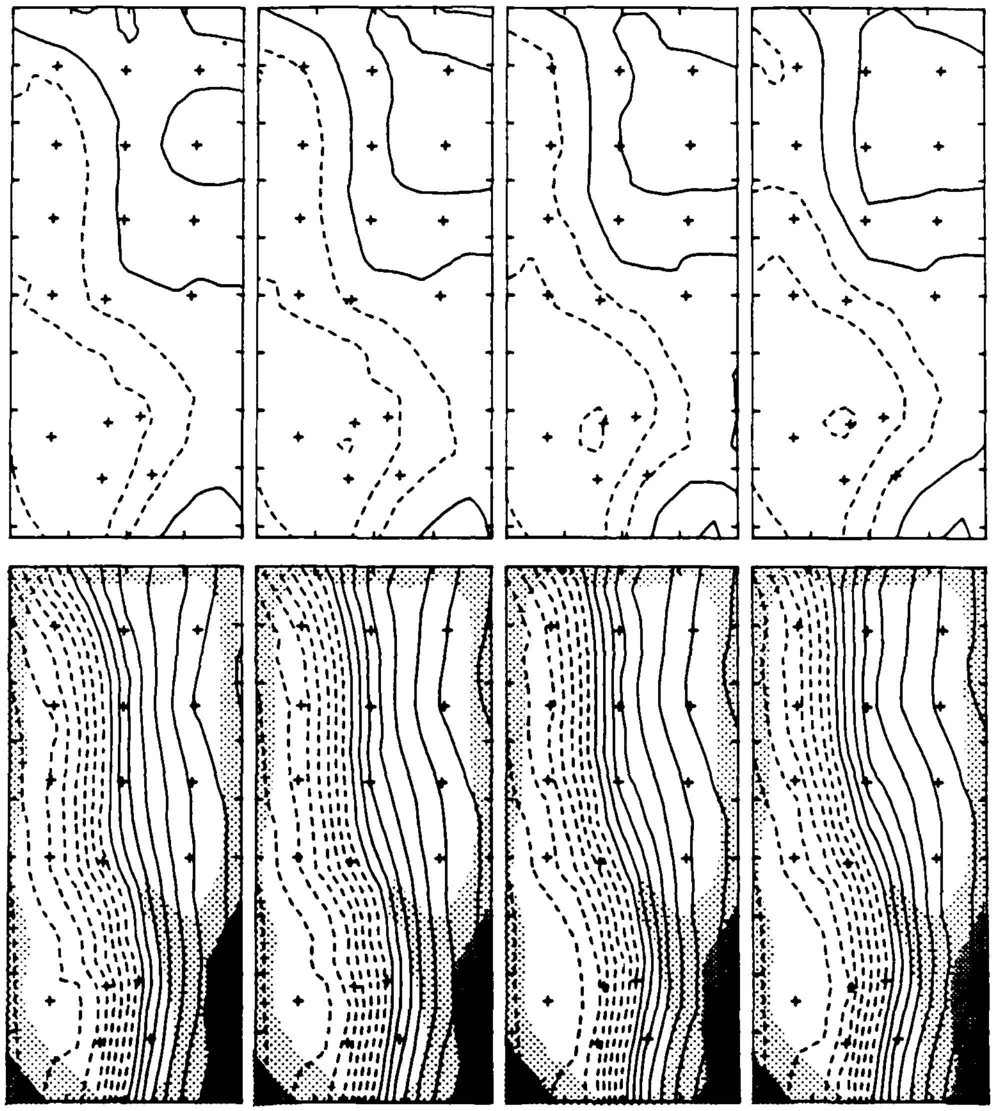

21 OCT 1983
22 OCT 1983
23 OCT 1983
24 OCT 1983


25 OCT 1983
26 OCT 1983
27 OCT 1983
28 OCT 1983


29 OCT
1983
30 OCT
1983
31 OCT
1983
1 NOV
1983


2 NOV 1983
3 NOV 1983
4 NOV 1983
5 NOV 1983


6 NOV 1983
7 NOV 1983
8 NOV 1983
9 NOV 1983

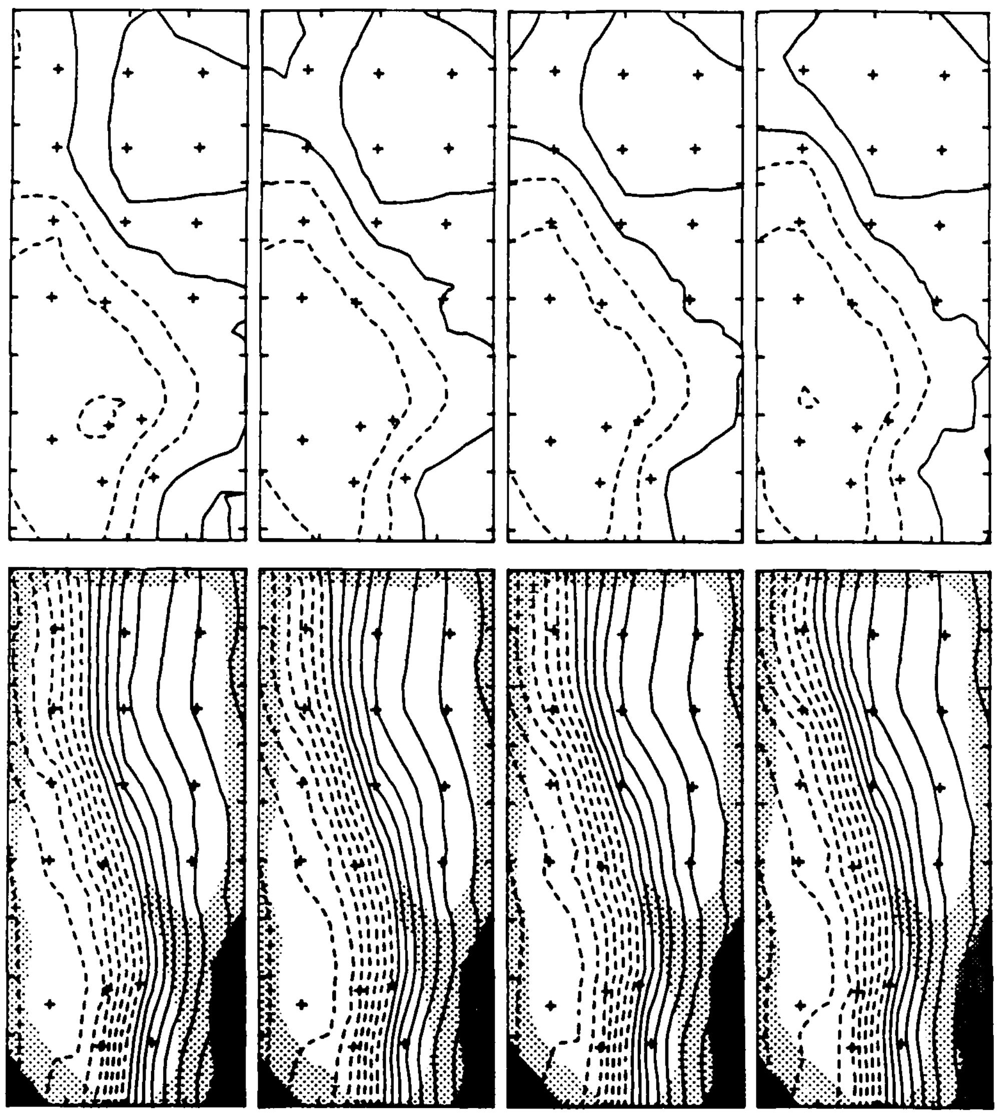


10 NOV 1983

11 NOV 1983

12 NOV 1983

13 NOV 1983

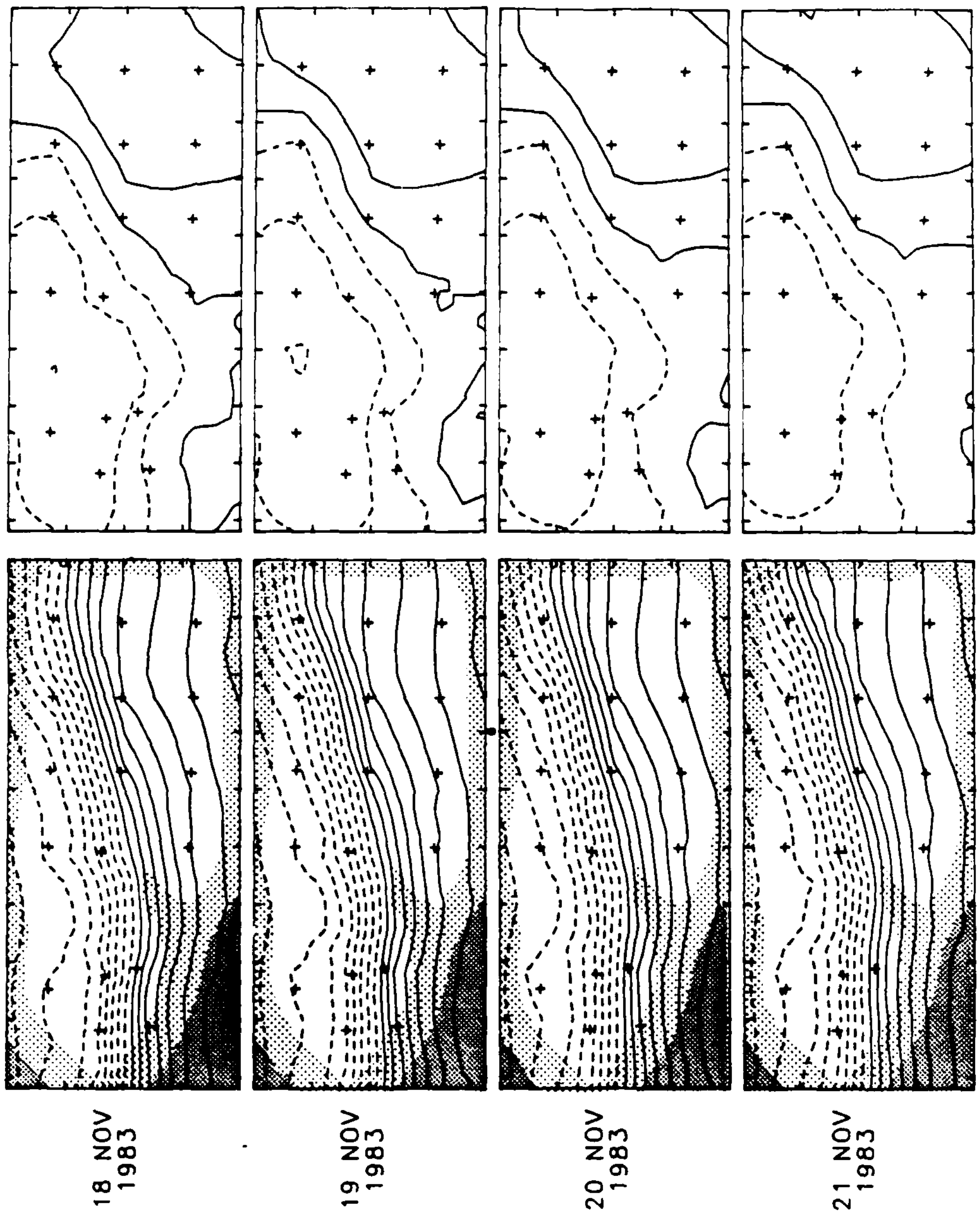


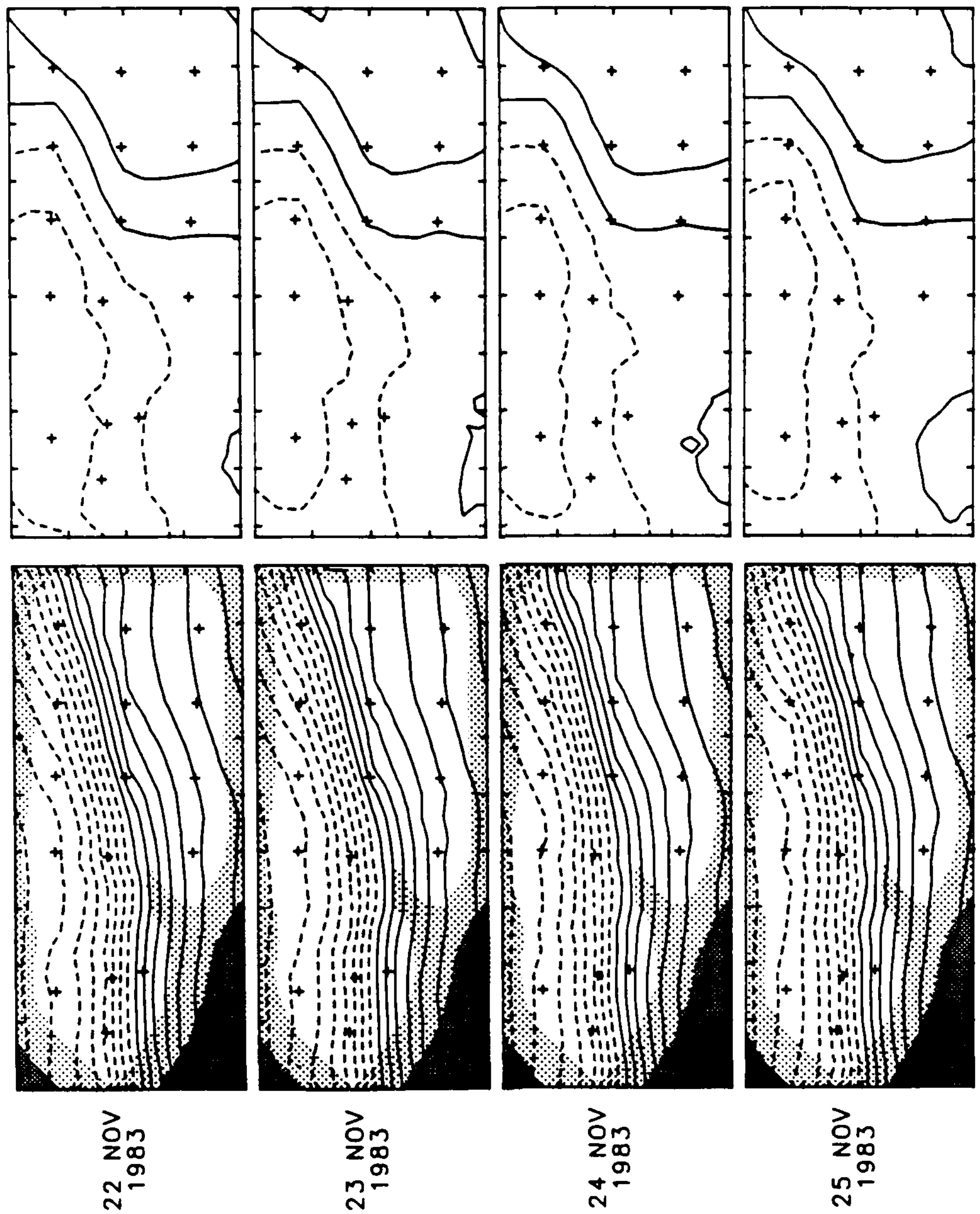
14 NOV 1983

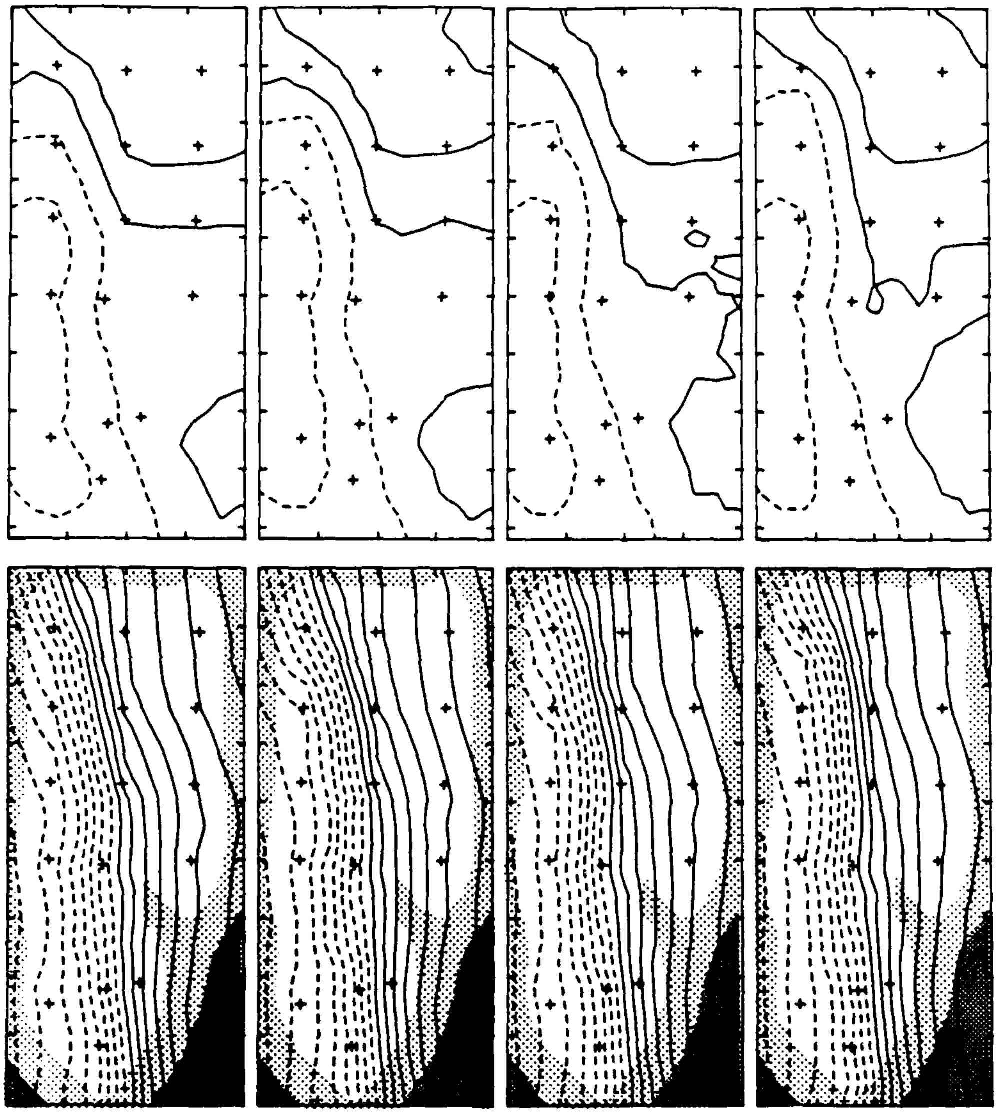
15 NOV 1983

16 NOV 1983

17 NOV 1983


18 NOV 1983
19 NOV 1983
20 NOV 1983
21 NOV 1983


22 NOV 1983
23 NOV 1983
24 NOV 1983
25 NOV 1983

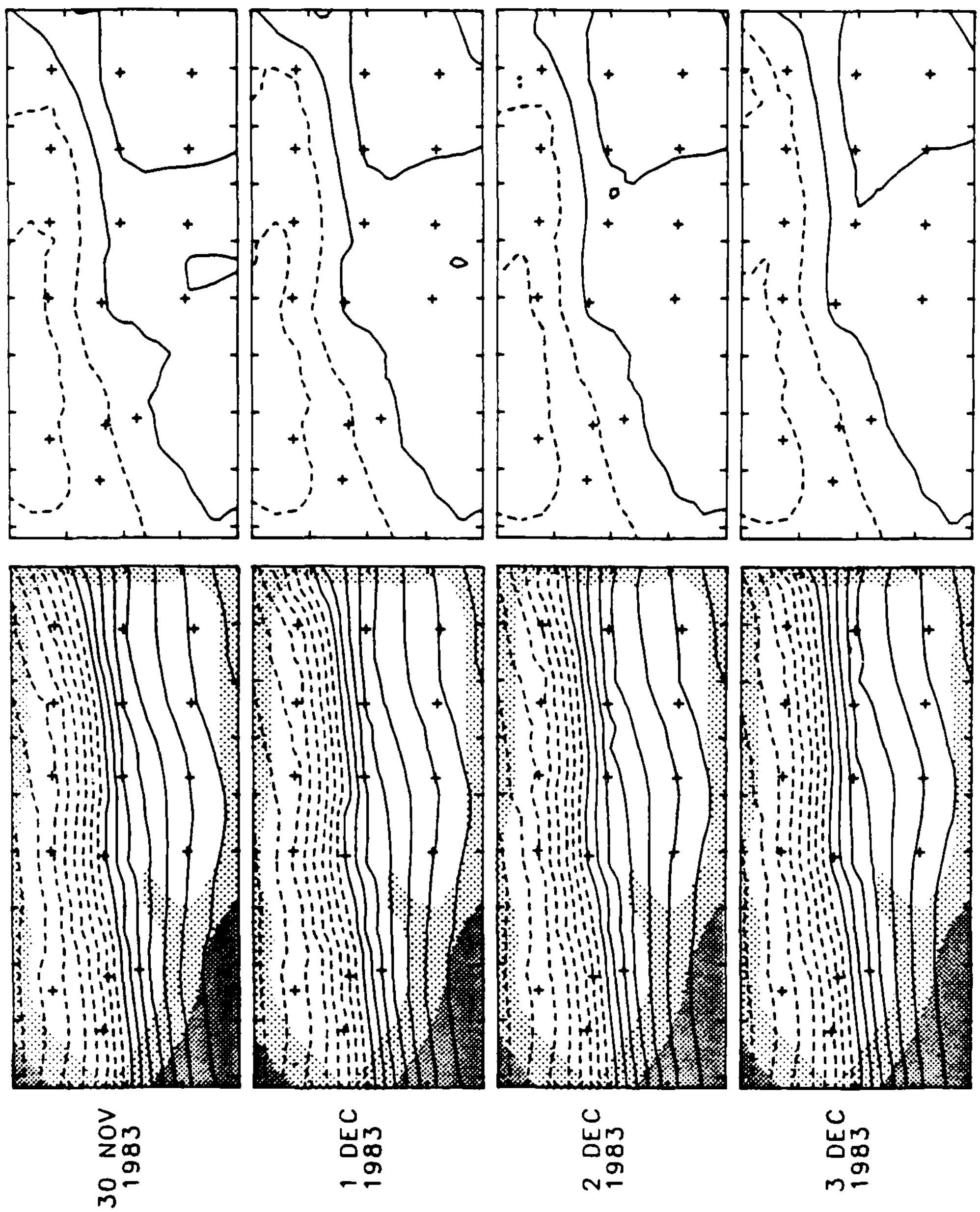


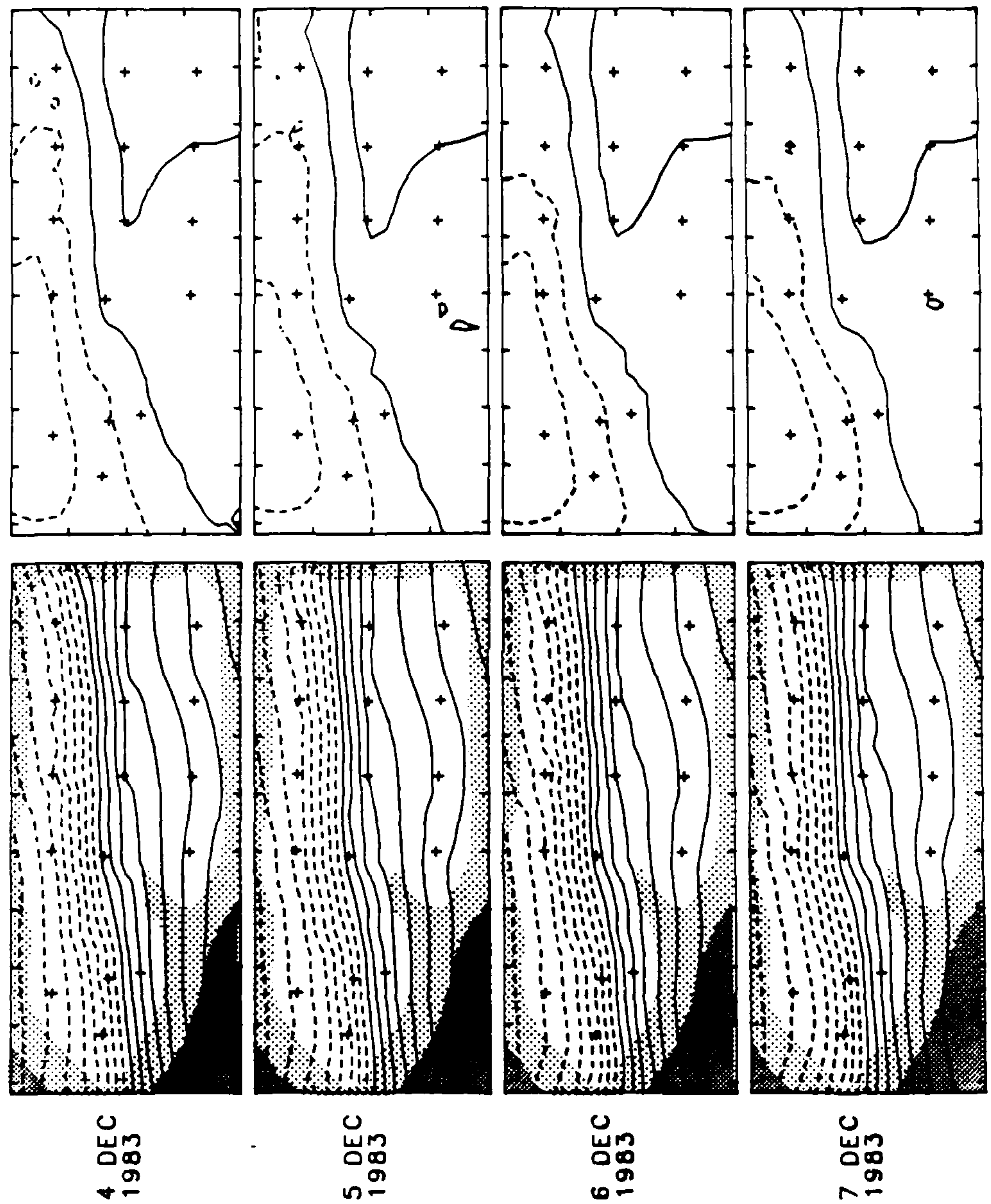
26 NOV 1983

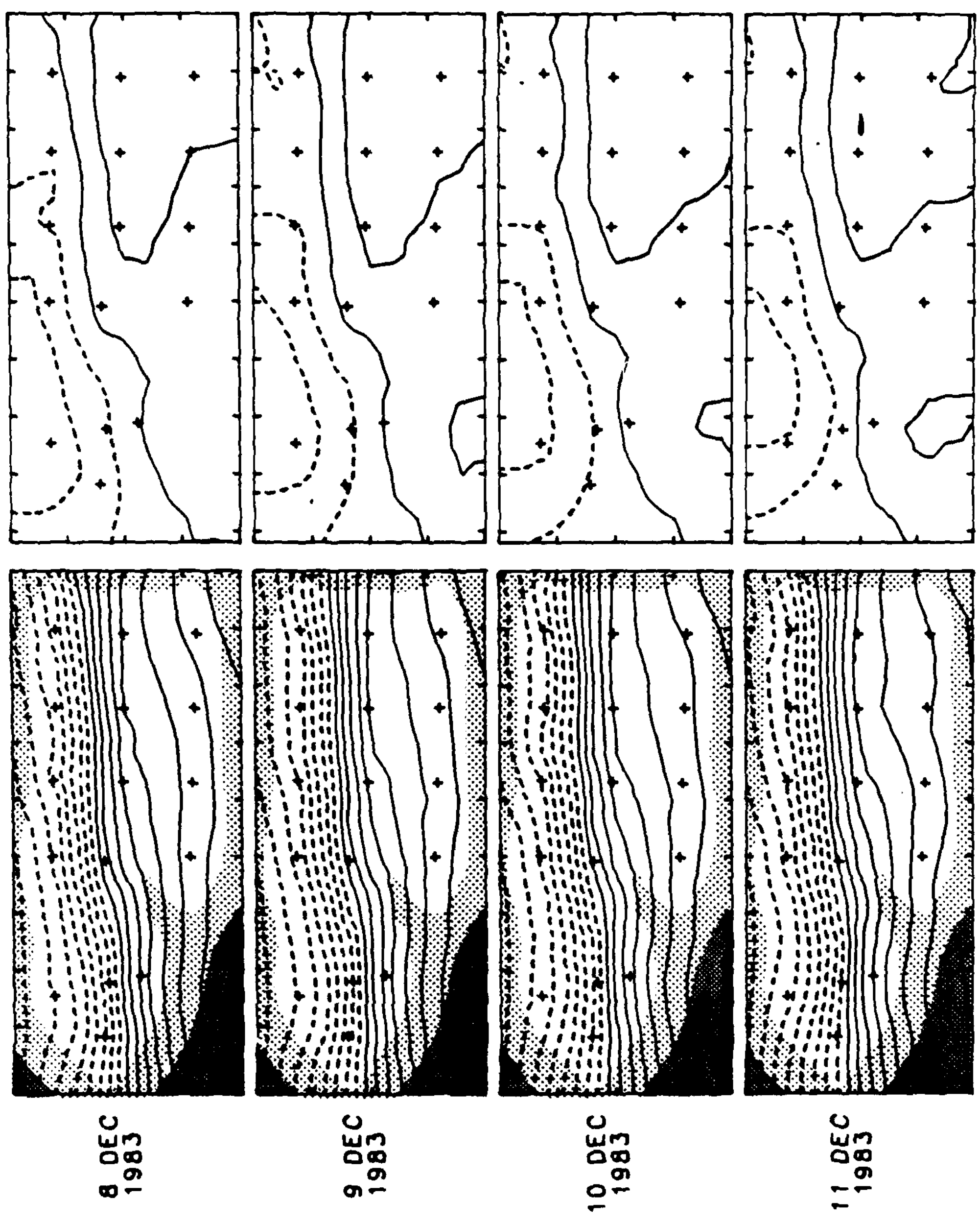
27 NOV 1983

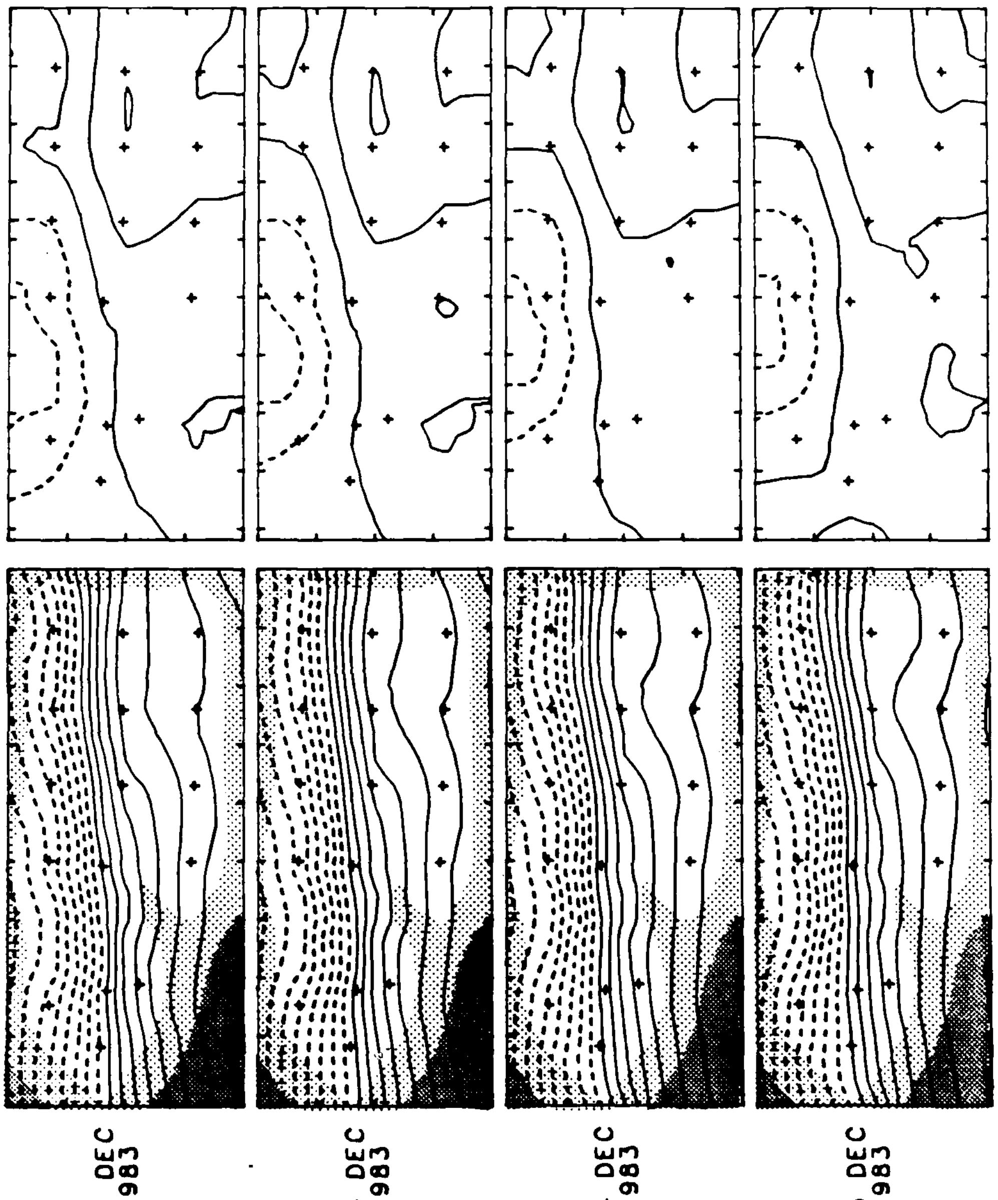
28 NOV 1983

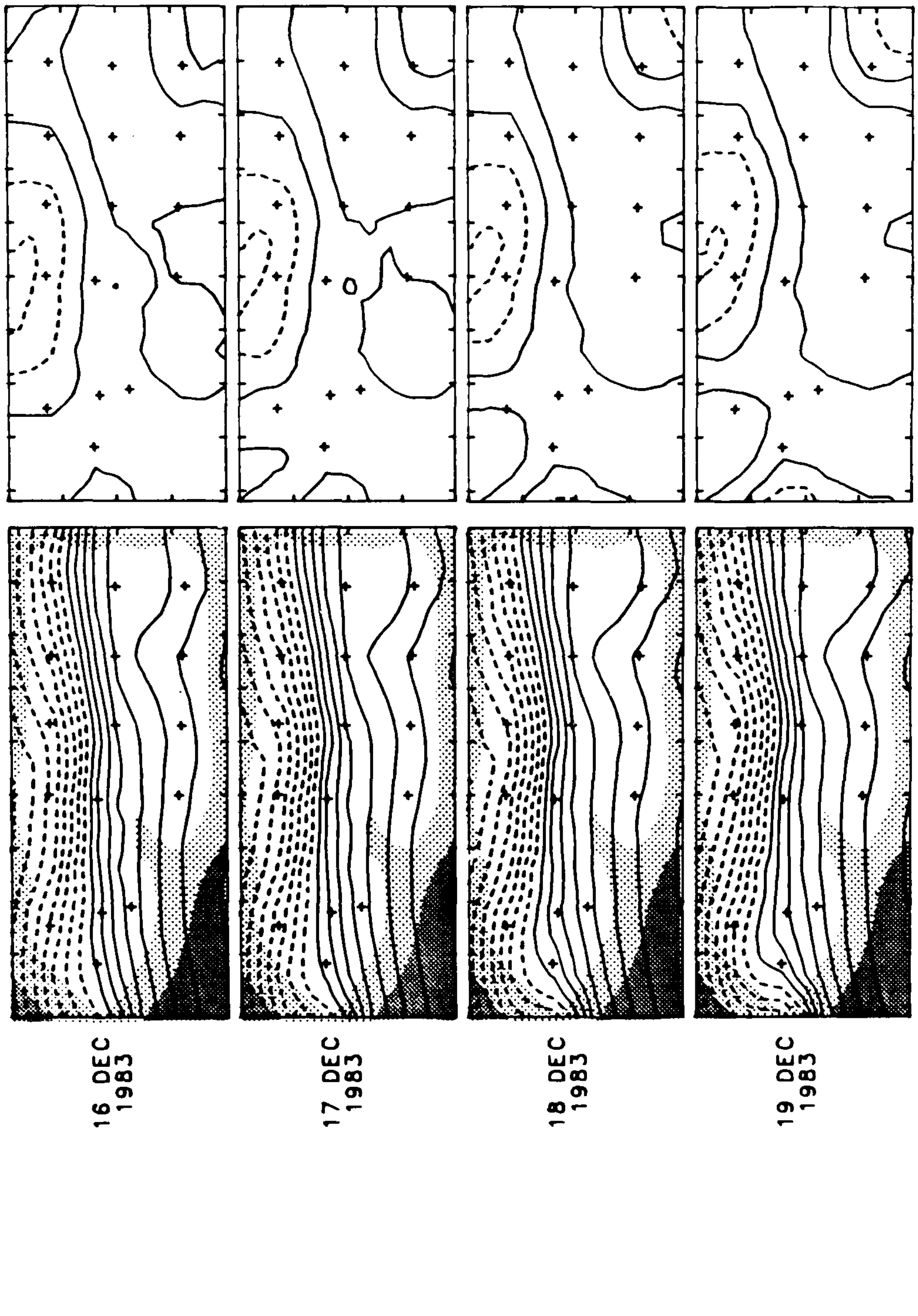
29 NOV 1983

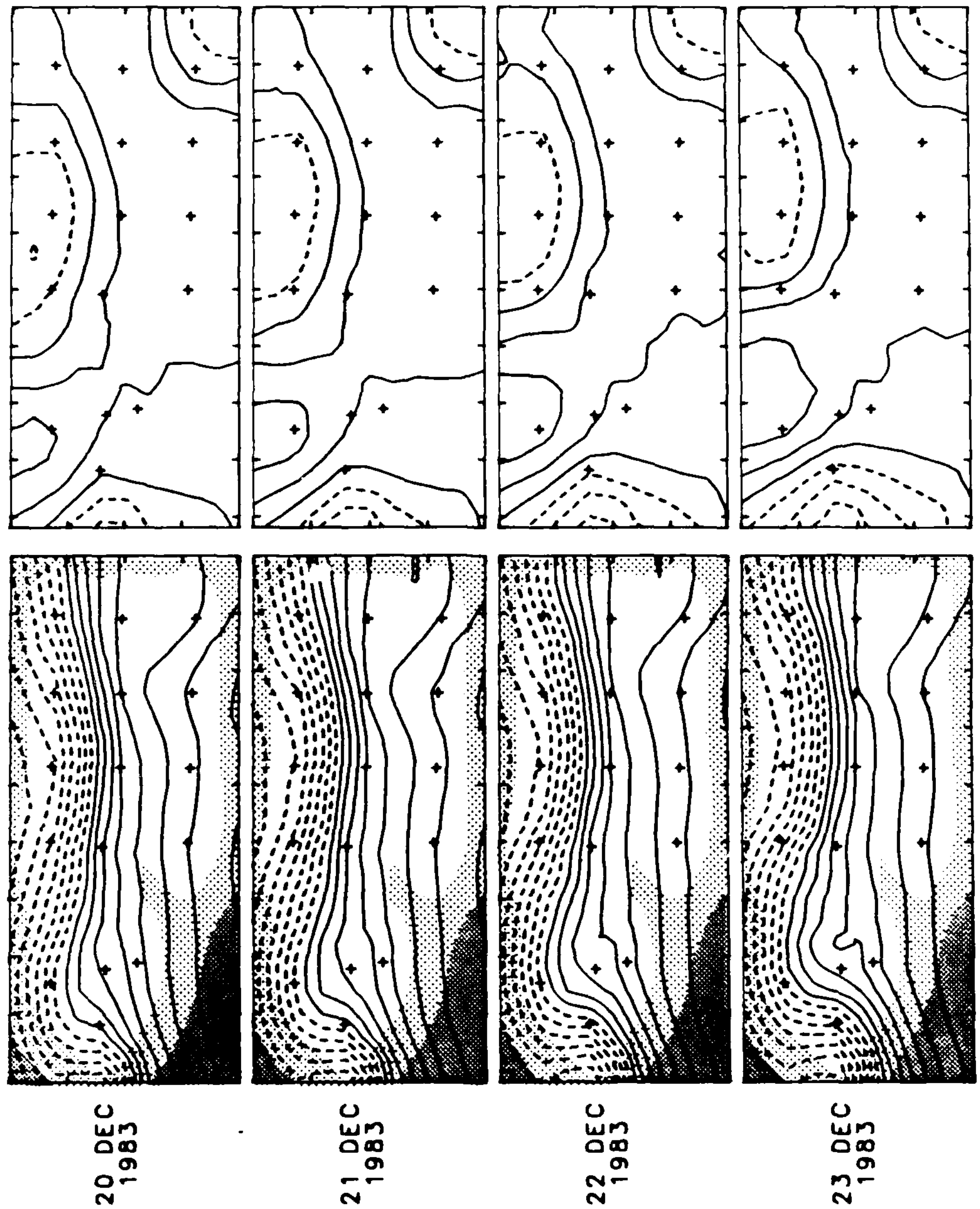

30 NOV
1983
1 DEC
1983
2 DEC
1983
3 DEC
1983

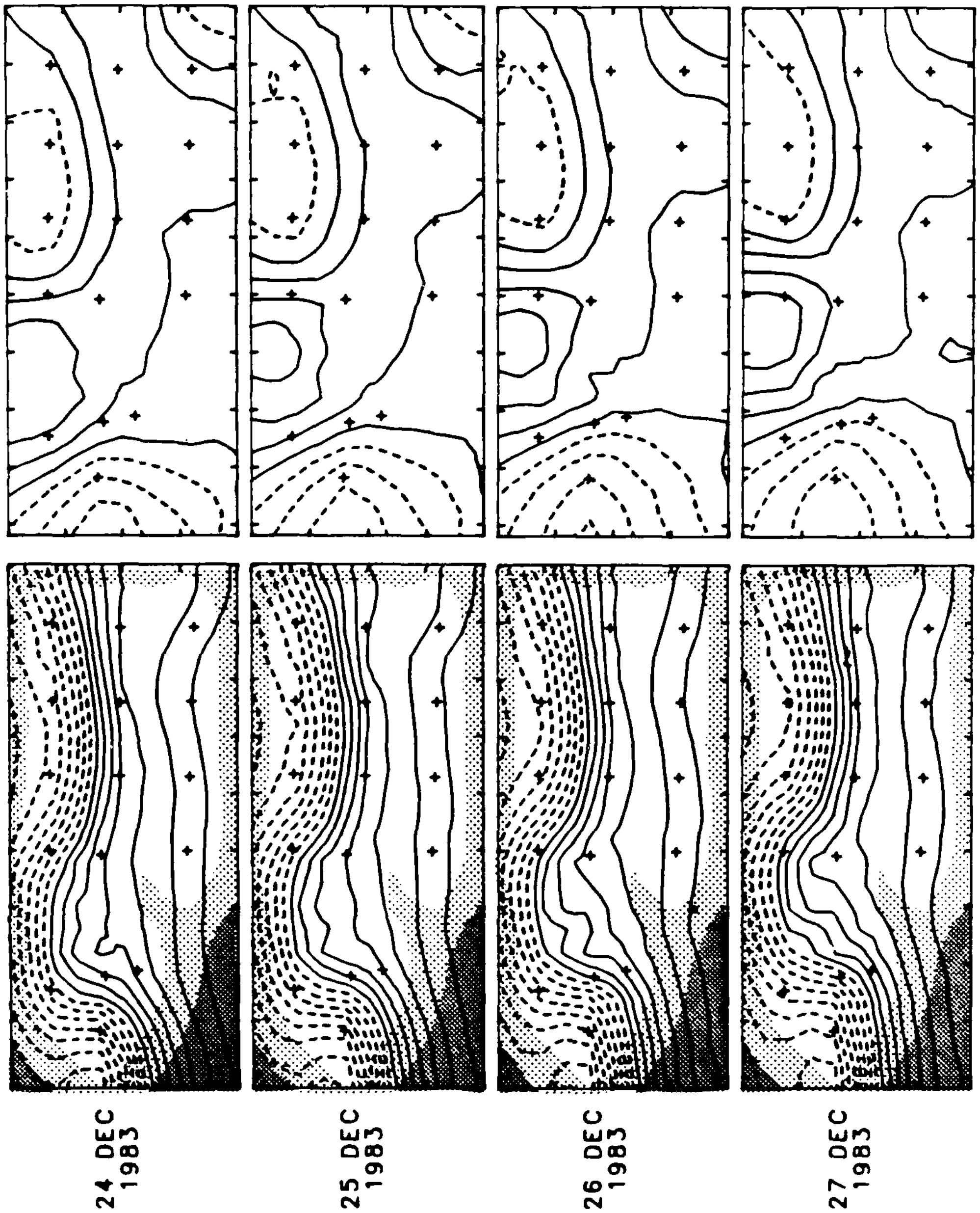

4 DEC
1983
5 DEC
1983
6 DEC
1983
7 DEC
1983


8 DEC
1983
9 DEC
1983
10 DEC
1983
11 DEC
1983

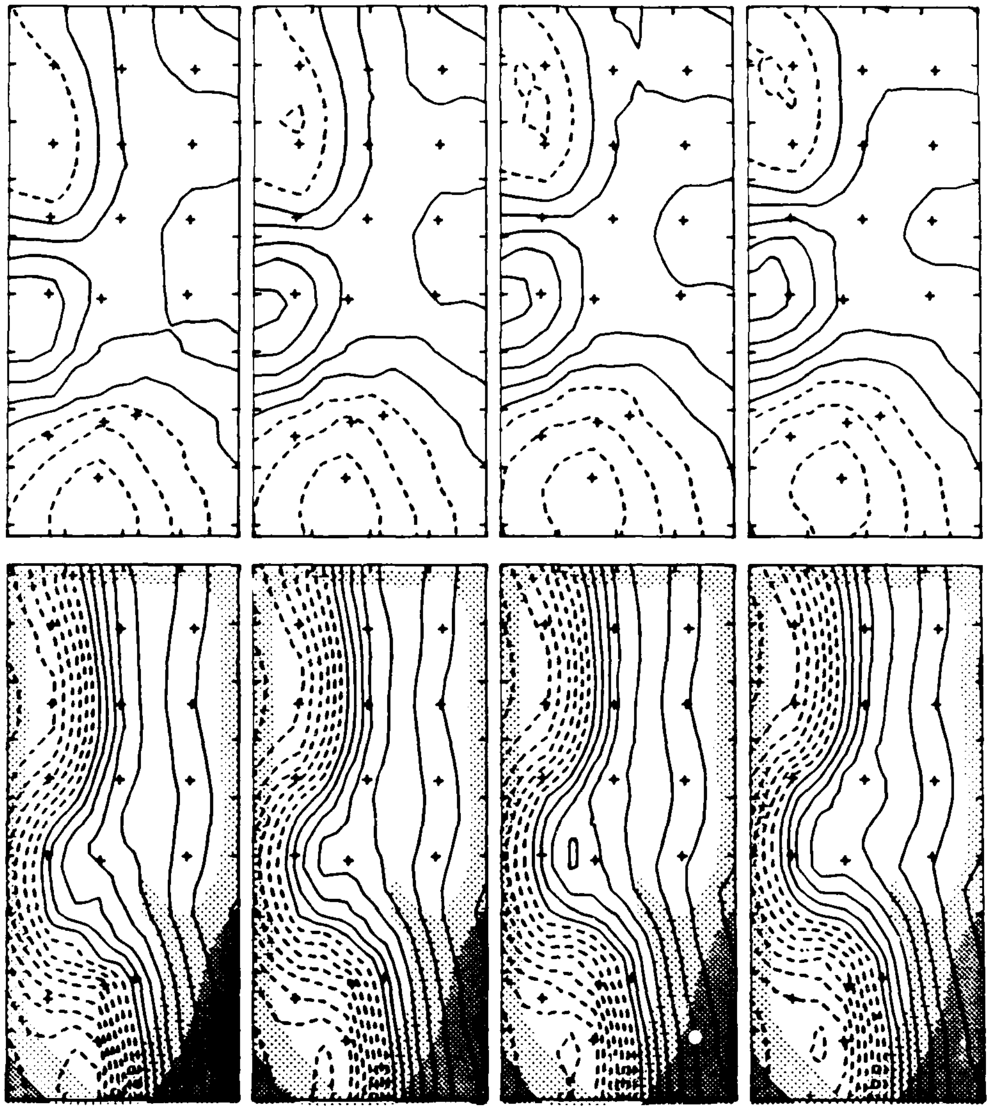

12 DEC 1983
13 DEC 1983
14 DEC 1983
15 DEC 1983


16 DEC 1983
17 DEC 1983
18 DEC 1983
19 DEC 1983


20 DEC 1983
21 DEC 1983
22 DEC 1983
23 DEC 1983



24 DEC 1983
25 DEC 1983
26 DEC 1983
27 DEC 1983



28 DEC 1983

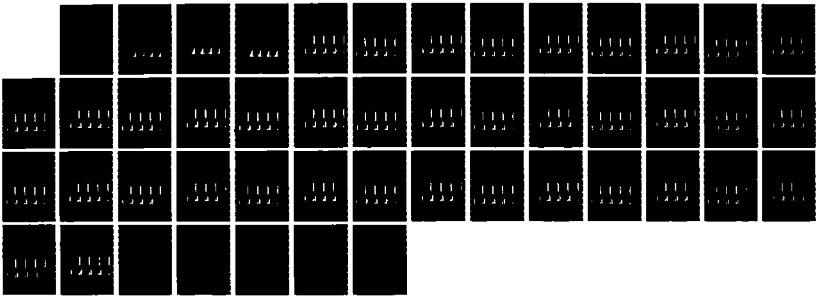
29 DEC 1983

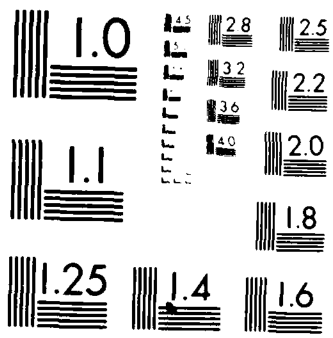
30 DEC 1983

31 DEC 1983

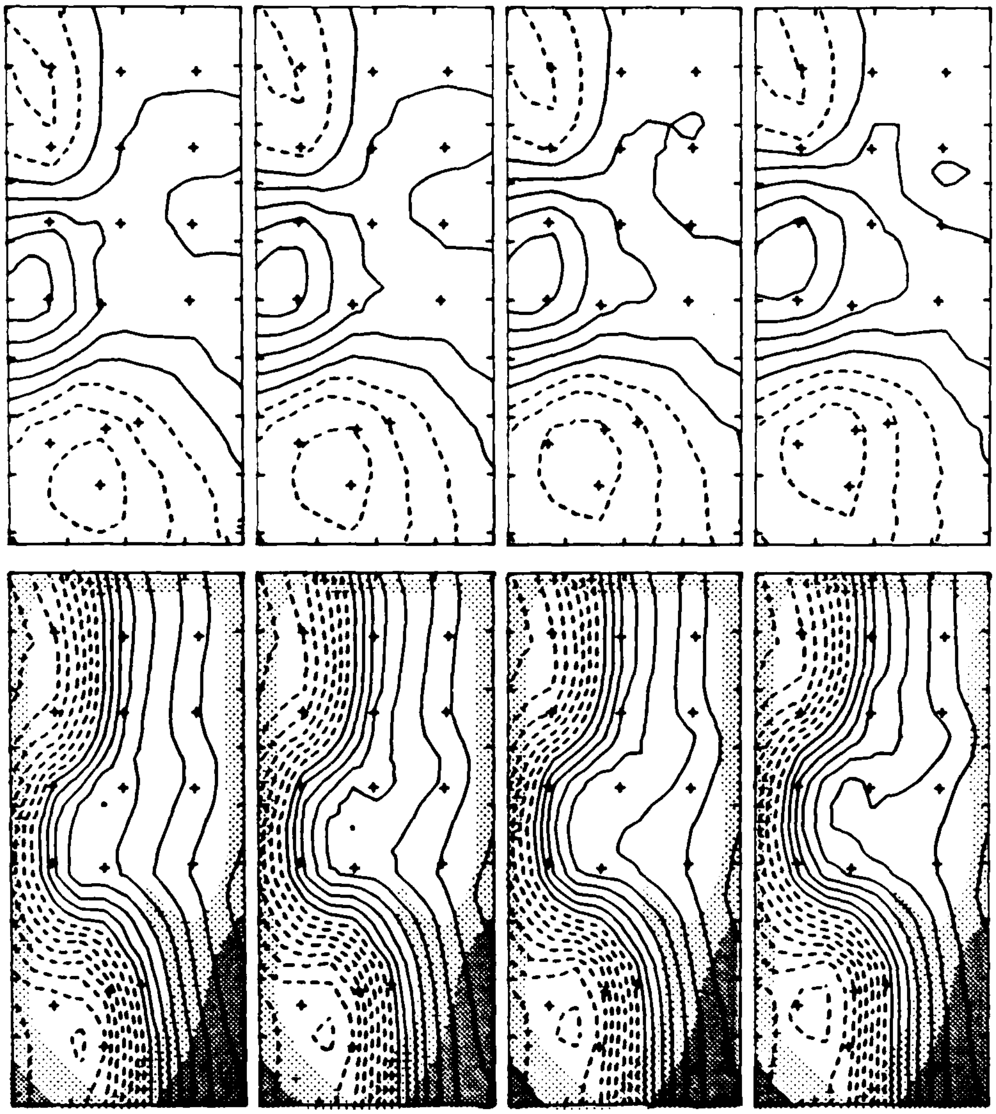
AD-A170 757 THE GULF STREAM DYNAMICS EXPERIMENT INVERTED ECHO SOUNDER DATA REPORT FOR..(U) RHODE ISLAND UNIV KINGSTON GRADUATE SCHOOL OF OCEANOGRAPHY K L TRACEY ET AL. 3/3

UNCLASSIFIED APR 86 URI/GSO-TR-86-4 N00014-81-C-0062 F/G 8/10 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

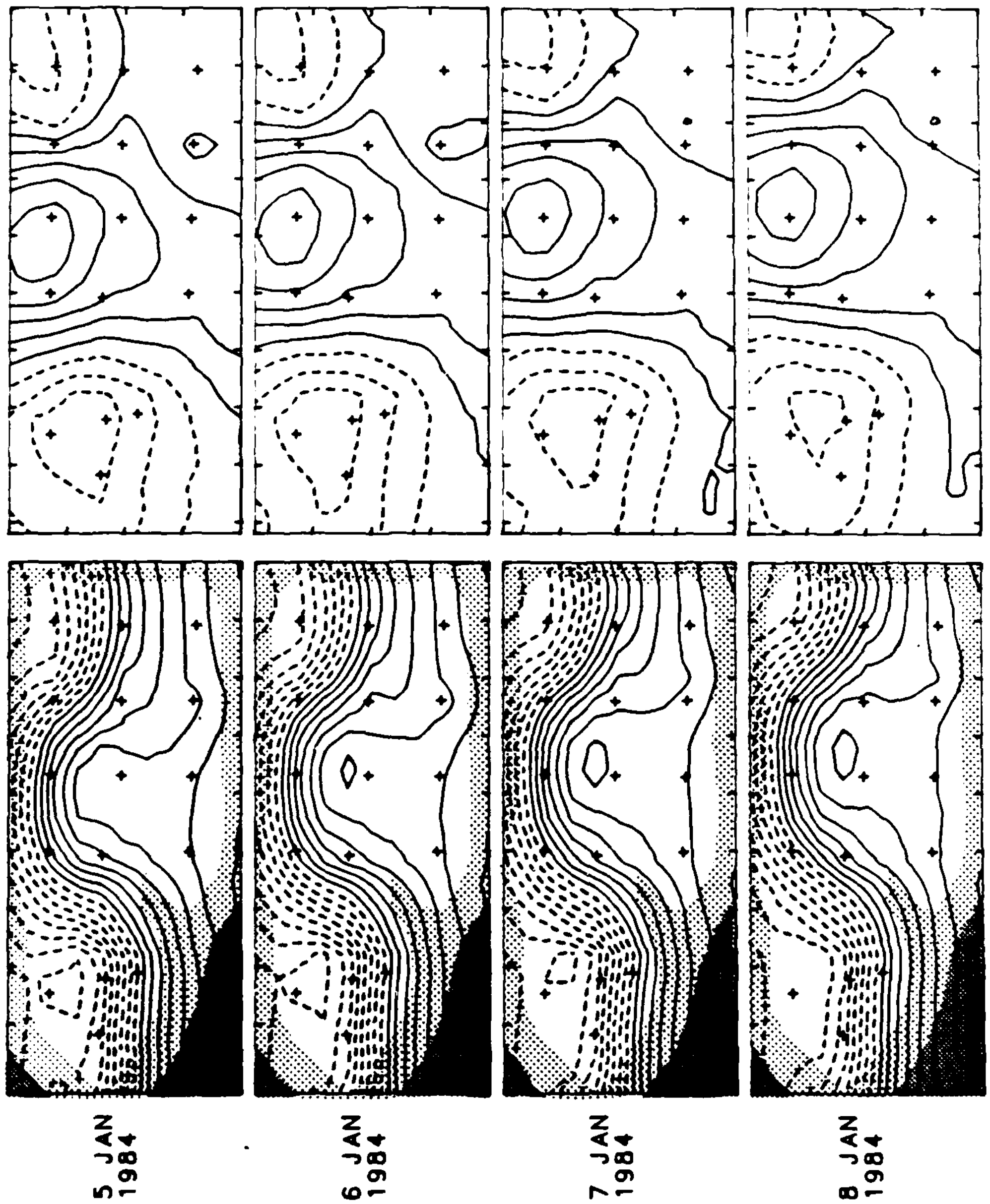


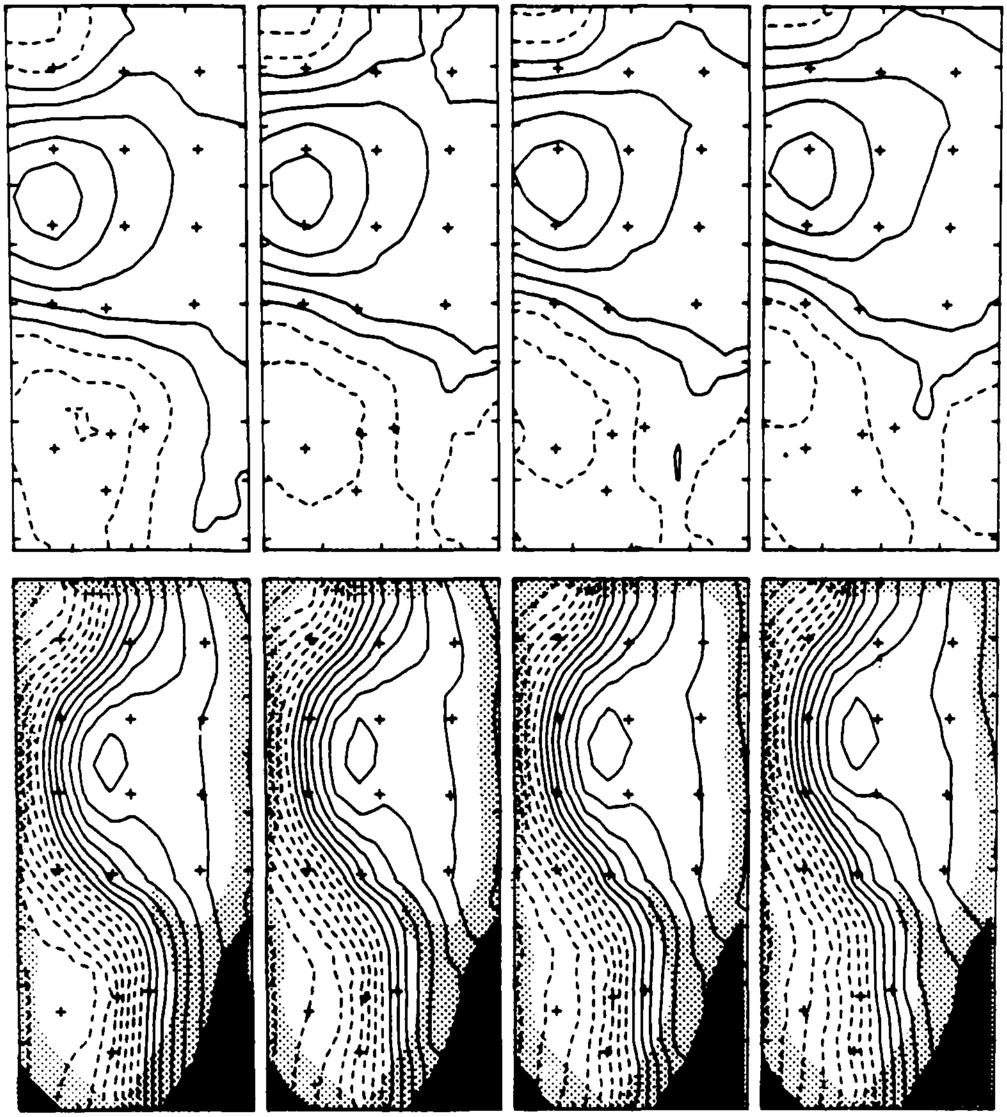
1 JAN 1984

2 JAN 1984

3 JAN 1984

4 JAN 1984


5 JAN 1984
6 JAN 1984
7 JAN 1984
8 JAN 1984

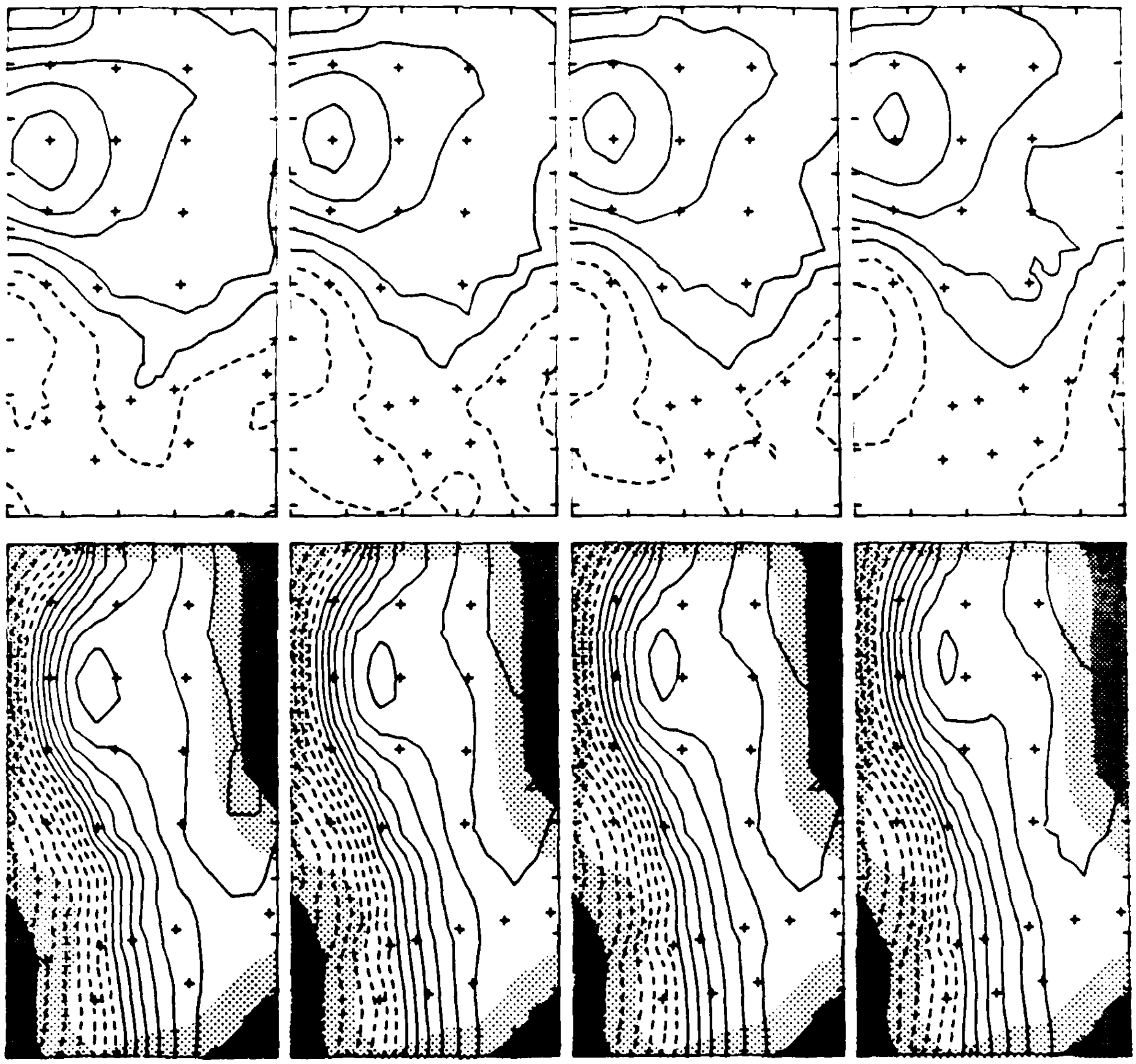


9 JAN 1984

10 JAN 1984

11 JAN 1984

12 JAN 1984

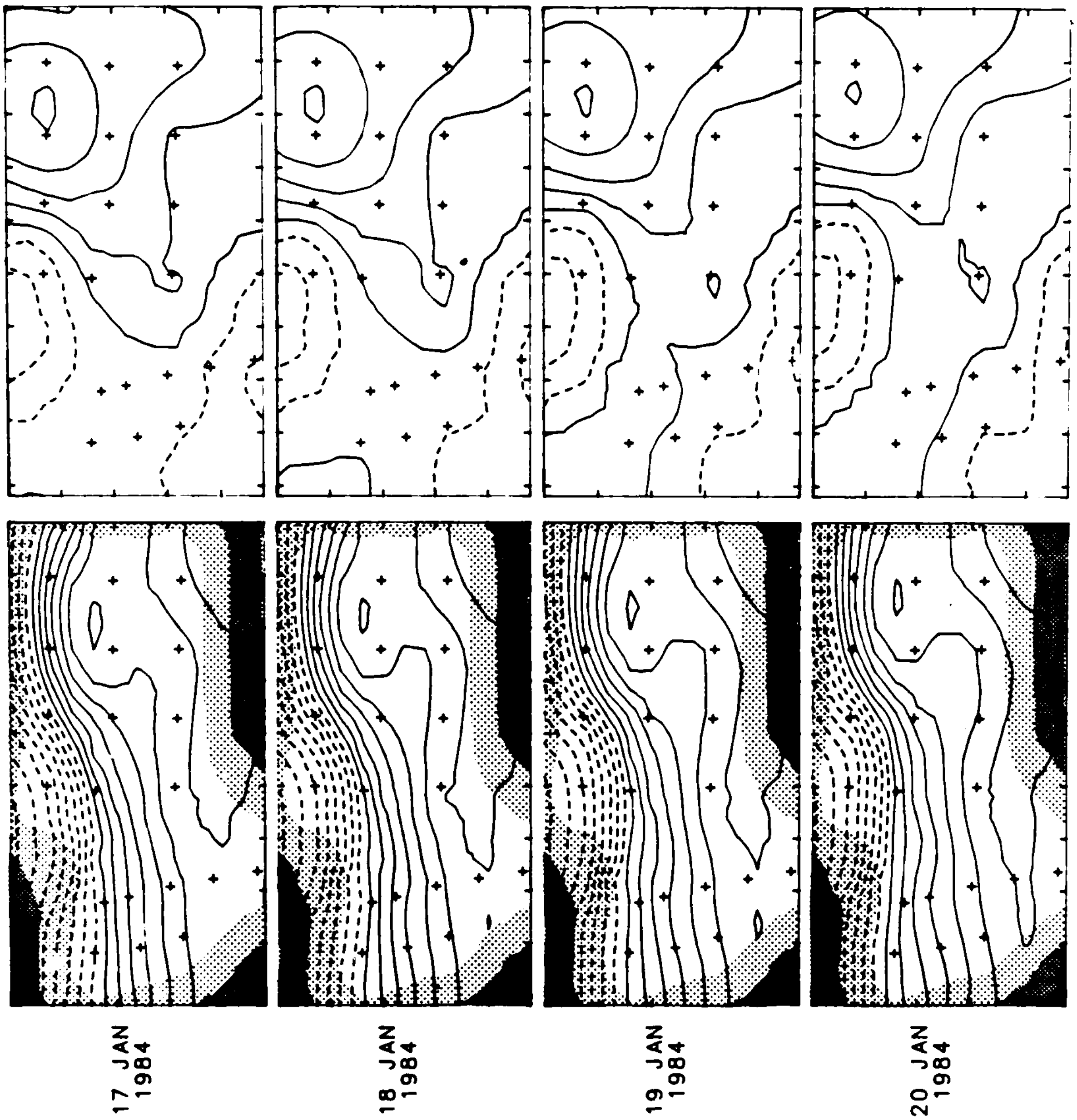


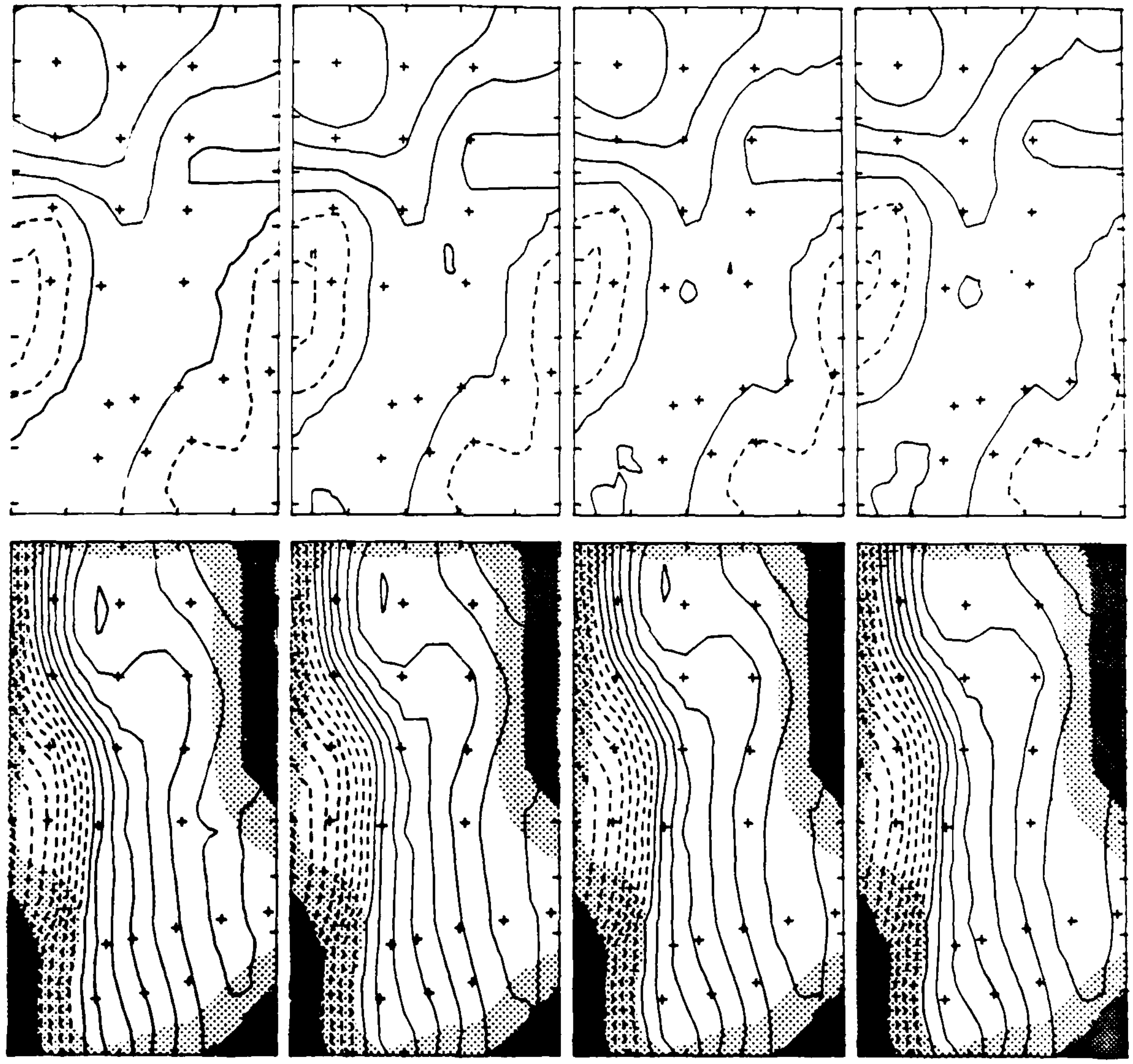
13 JAN 1984

14 JAN 1984

15 JAN 1984

16 JAN 1984


17 JAN 1984
18 JAN 1984
19 JAN 1984
20 JAN 1984

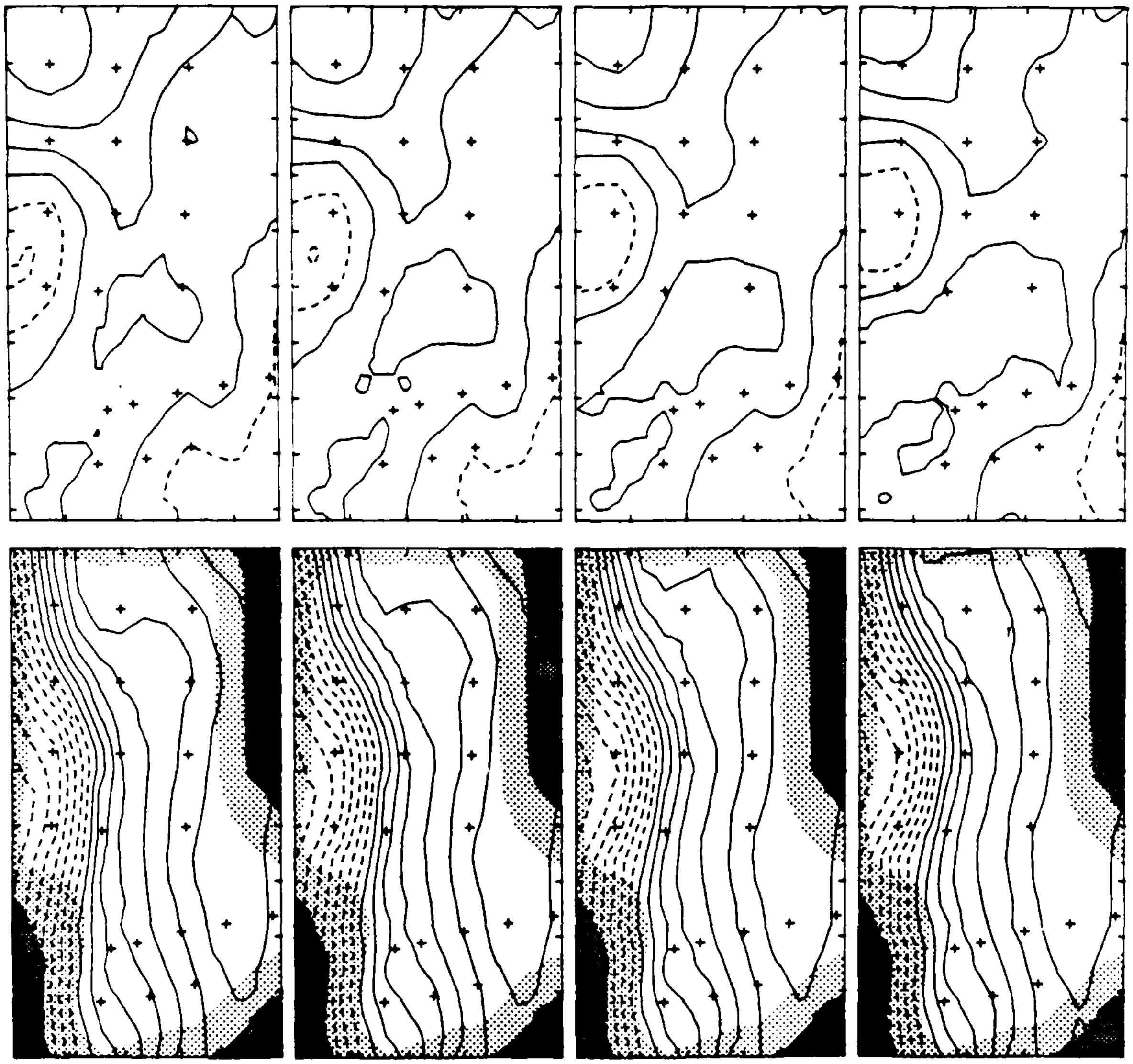


21 JAN 1984

22 JAN 1984

23 JAN 1984

24 JAN 1984

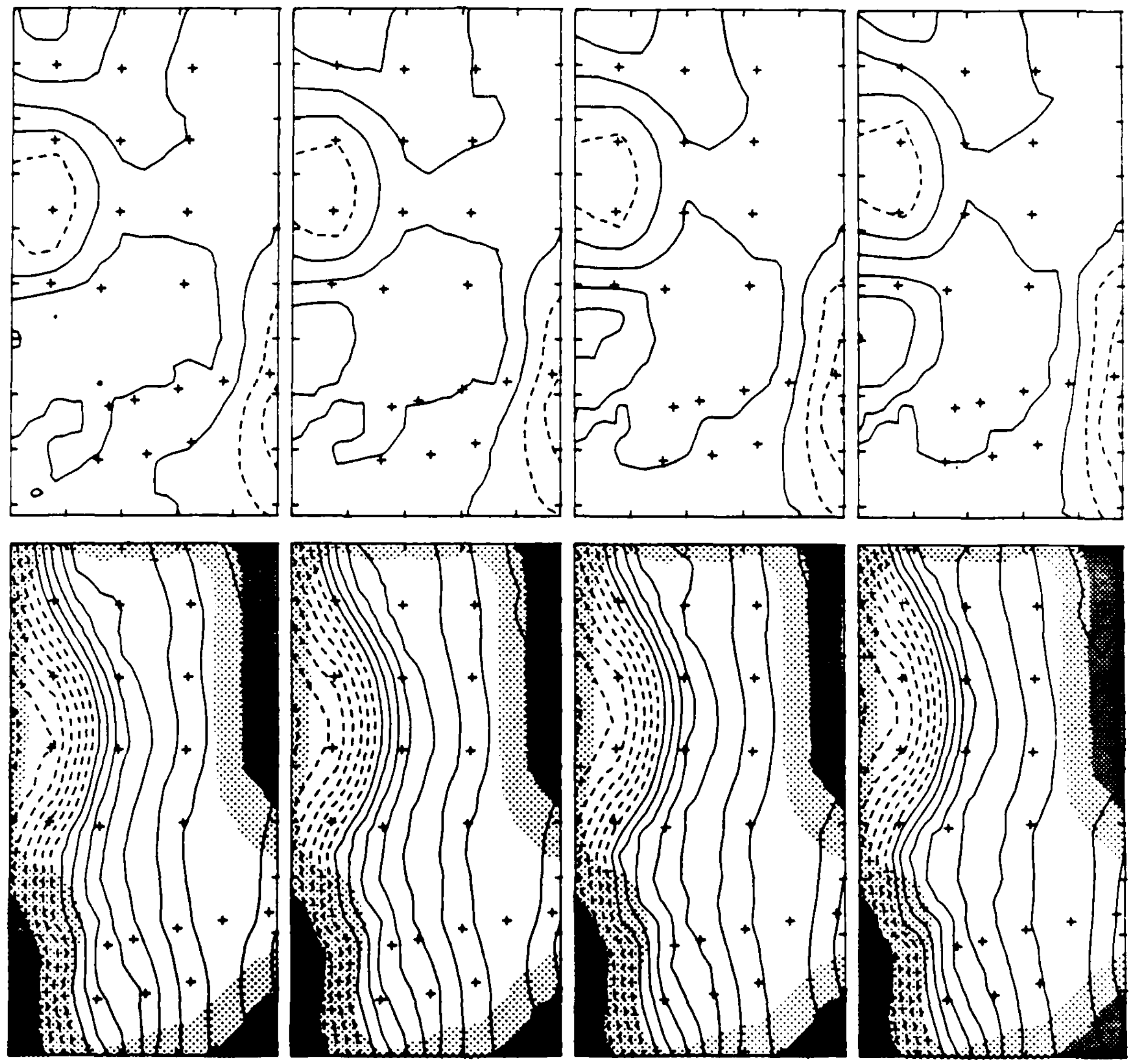


25 JAN 1984

26 JAN 1984

27 JAN 1984

28 JAN 1984

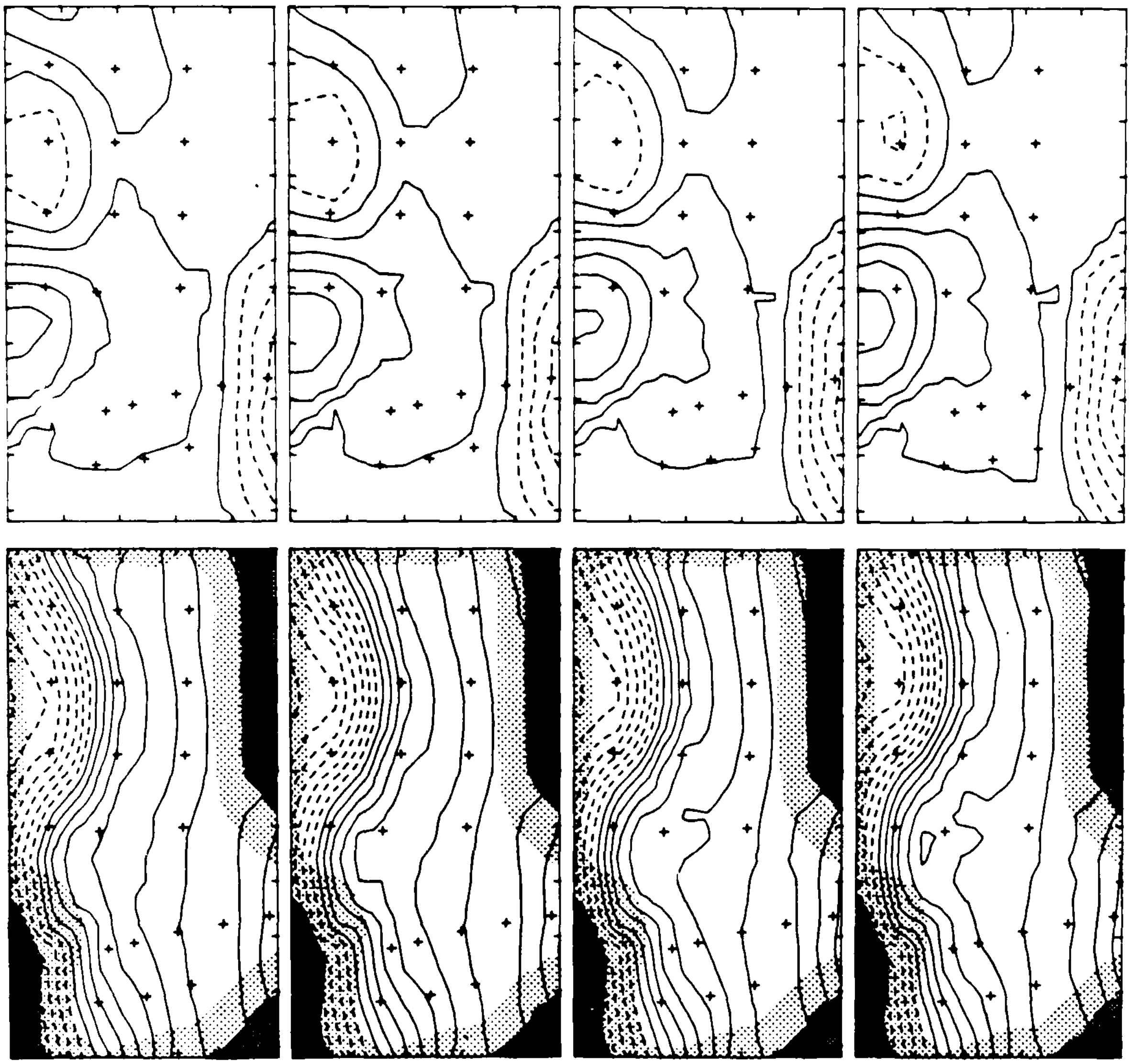


29 JAN 1984

30 JAN 1984

31 JAN 1984

1 FEB 1984

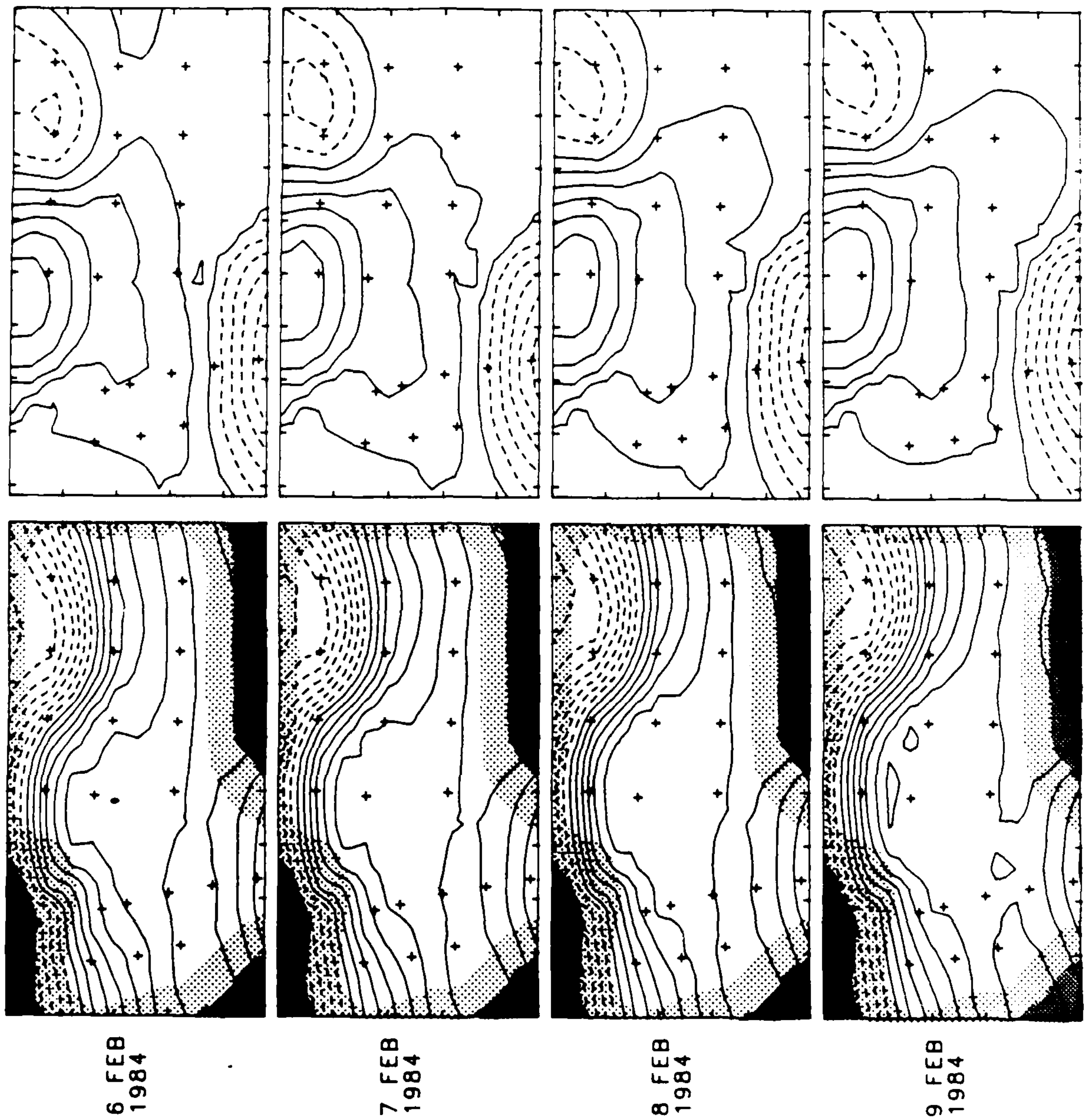


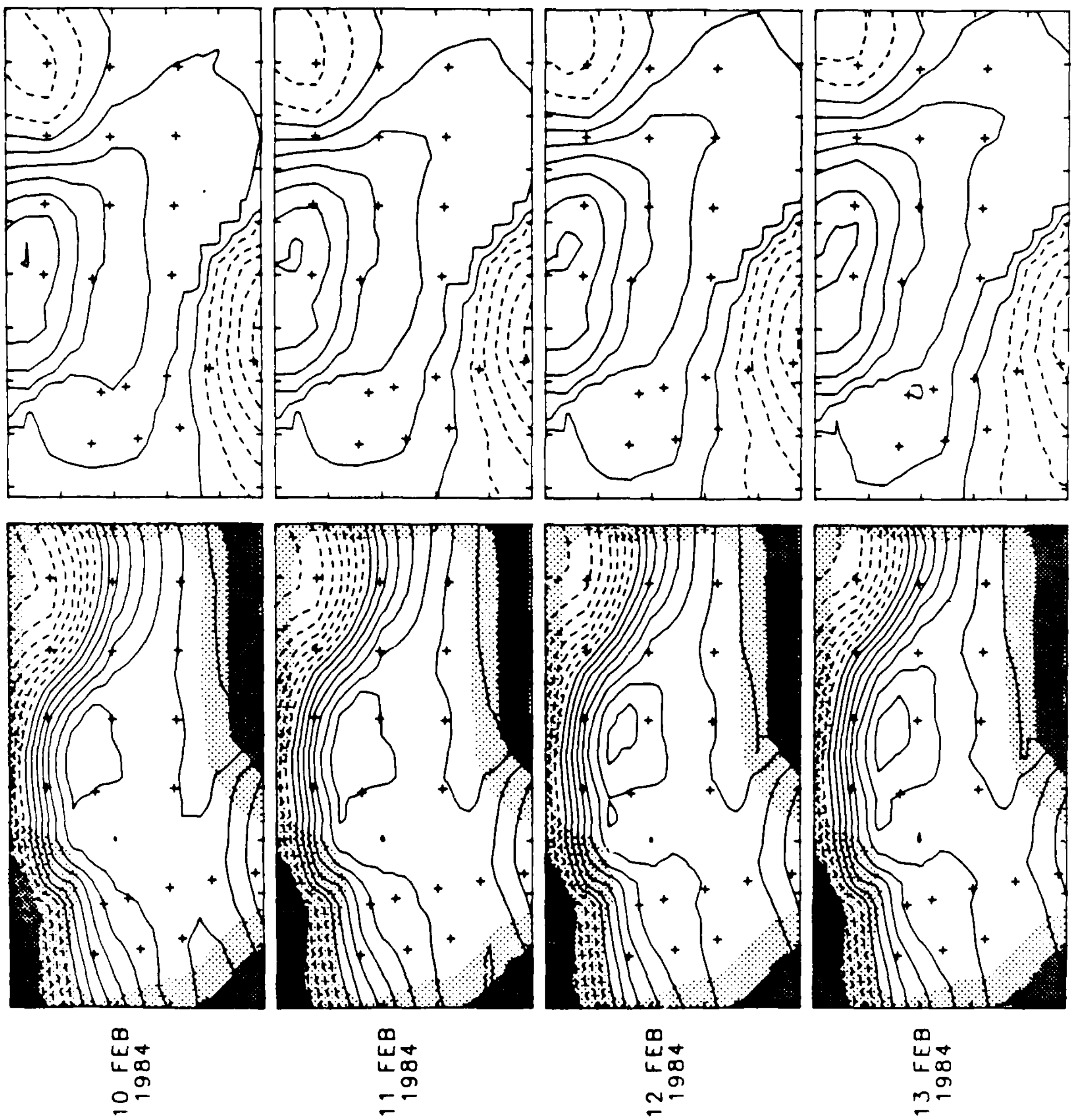
2 FEB 1984

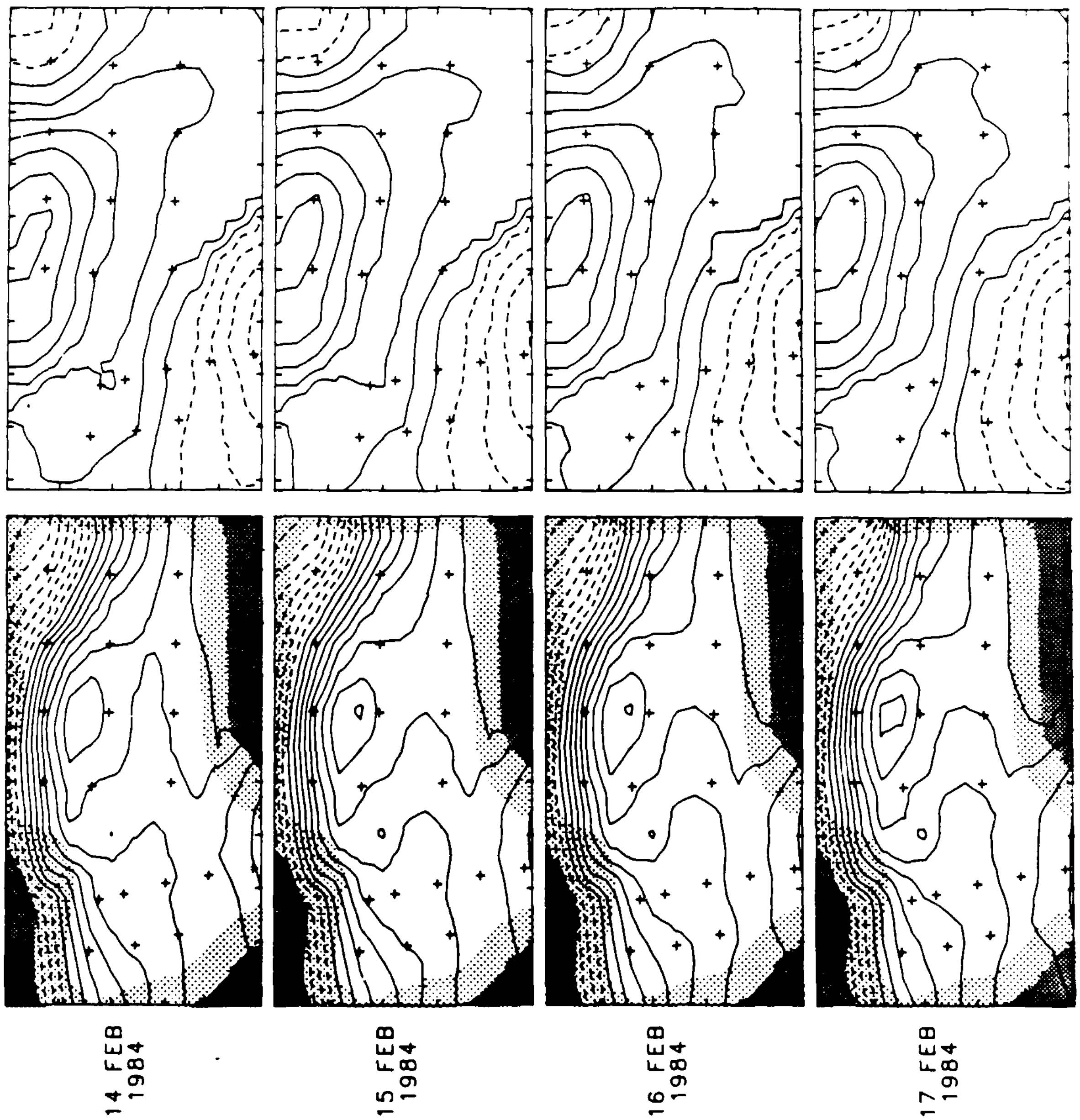
3 FEB 1984

4 FEB 1984

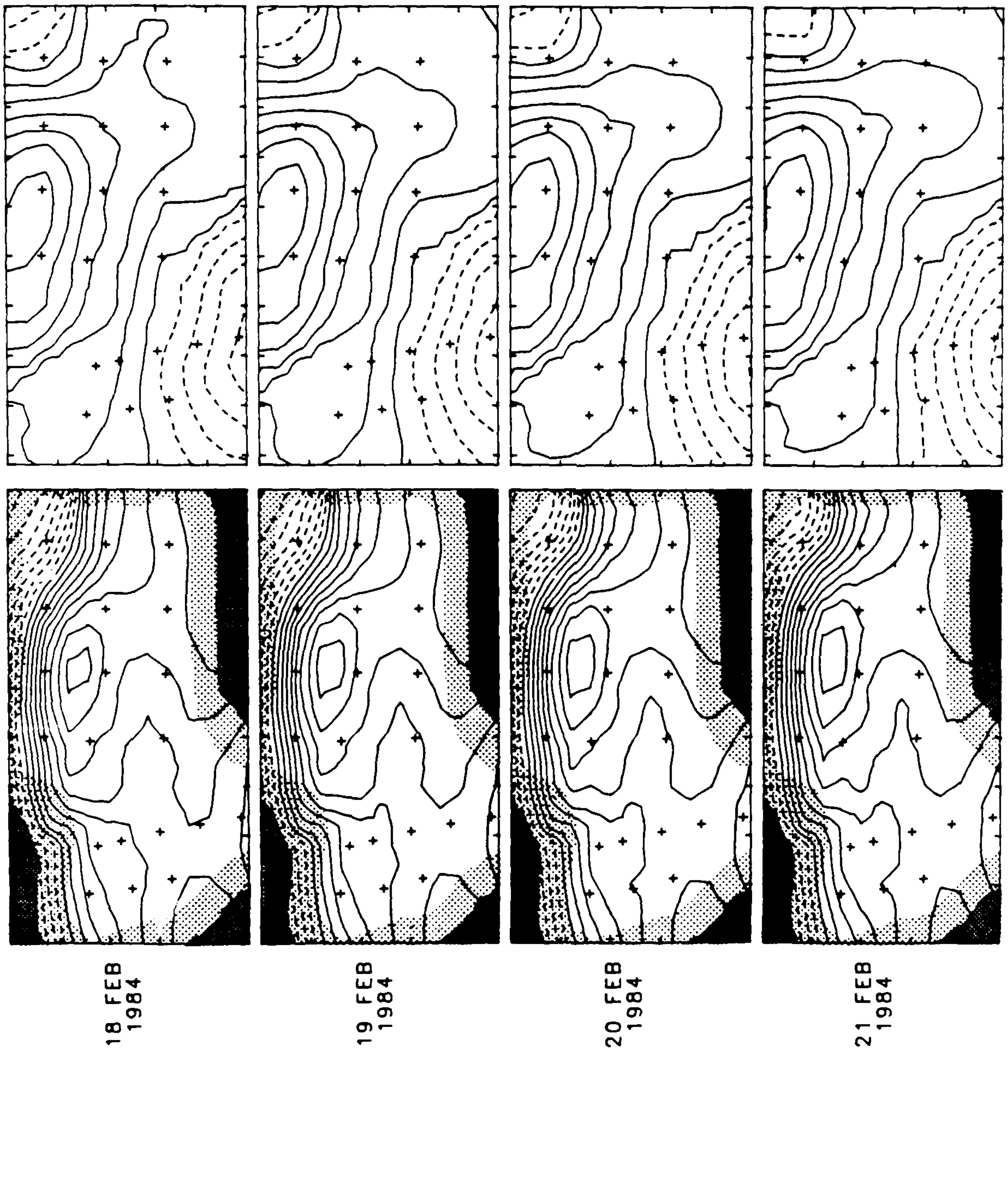
5 FEB 1984

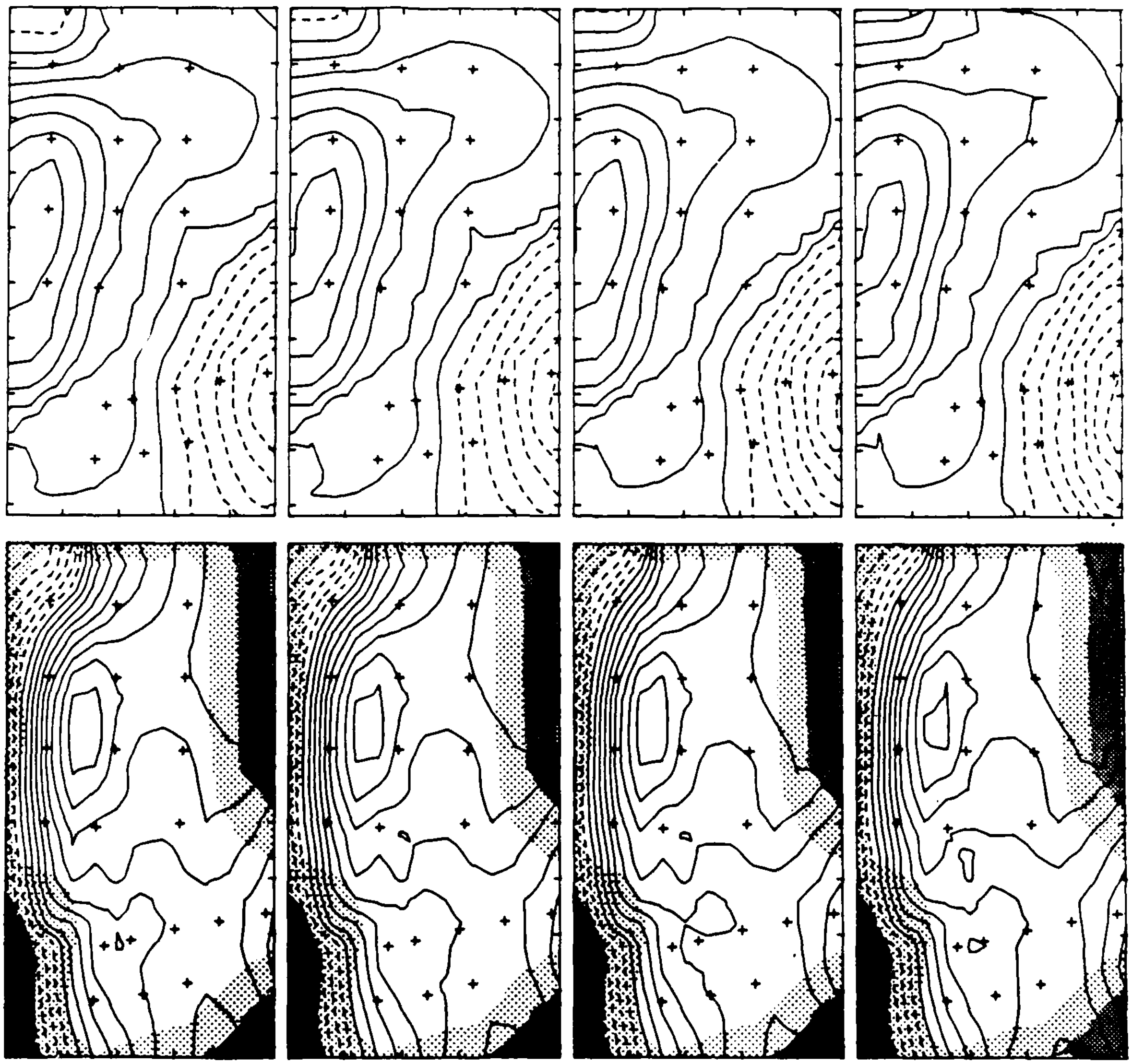

6 FEB 1984
7 FEB 1984
8 FEB 1984
9 FEB 1984


10 FEB 1984
11 FEB 1984
12 FEB 1984
13 FEB 1984



14 FEB 1984
15 FEB 1984
16 FEB 1984
17 FEB 1984


18 FEB 1984
19 FEB 1984
20 FEB 1984
21 FEB 1984

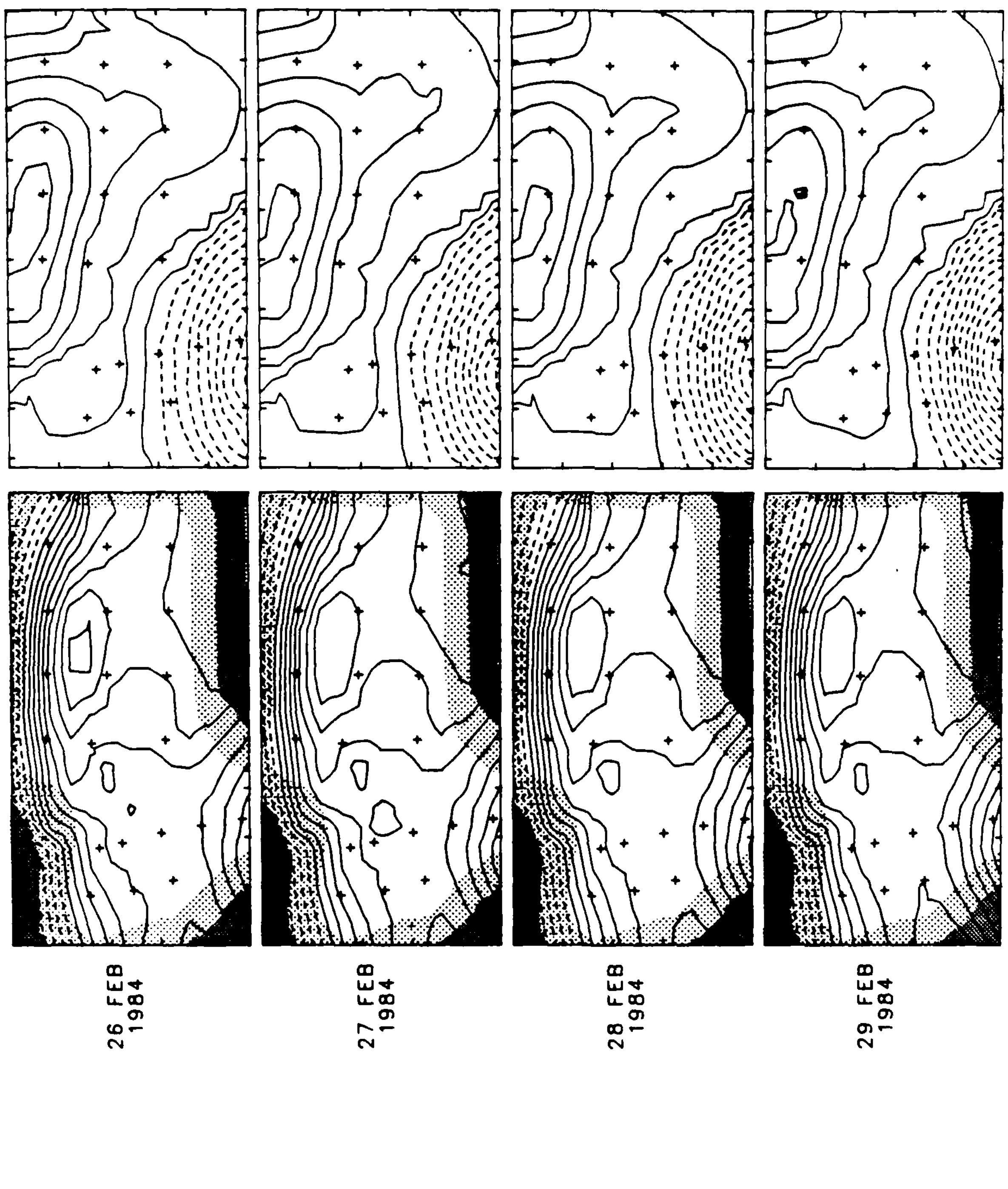


22 FEB 1984

23 FEB 1984

24 FEB 1984

25 FEB 1984

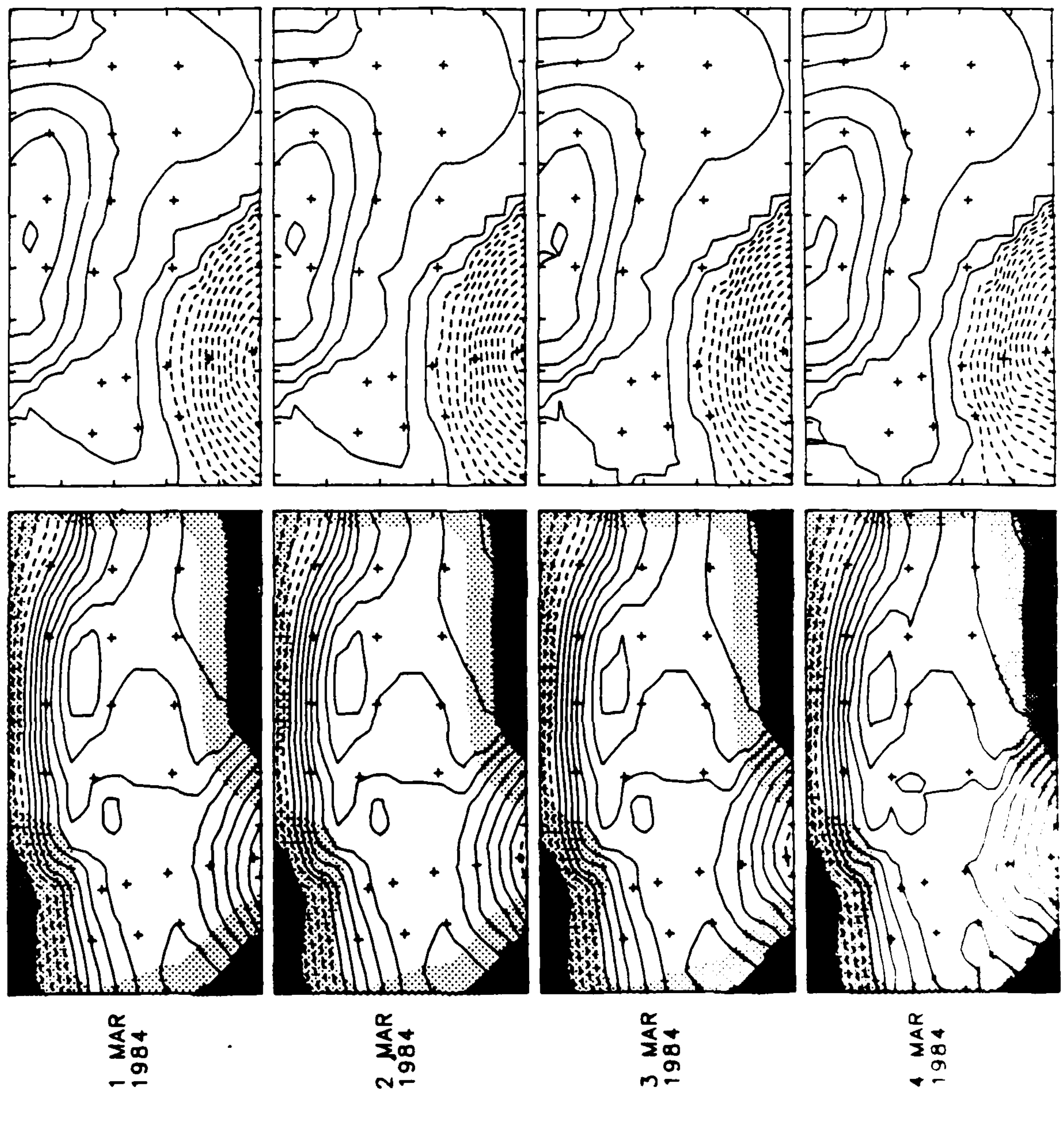


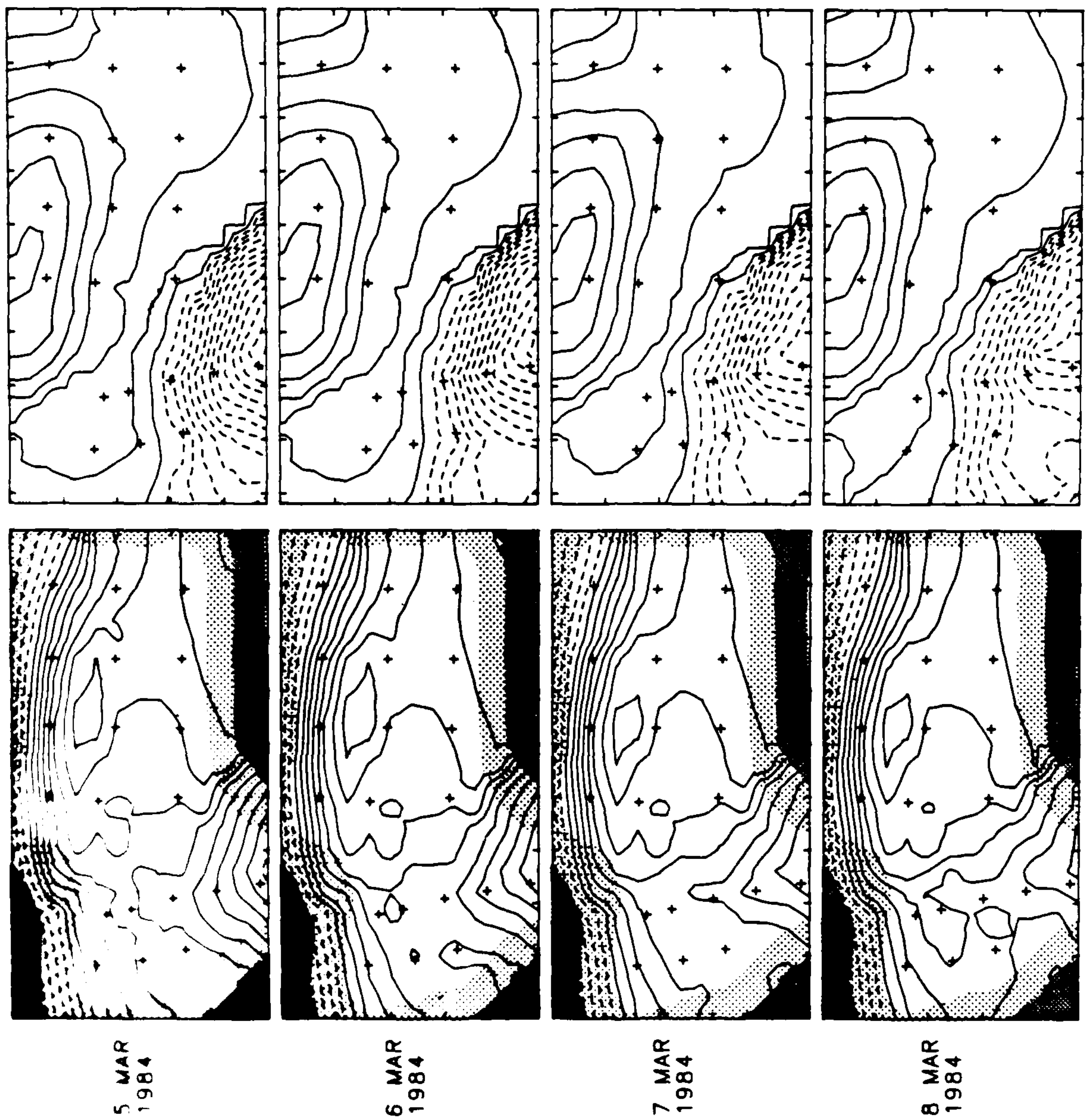
26 FEB 1984

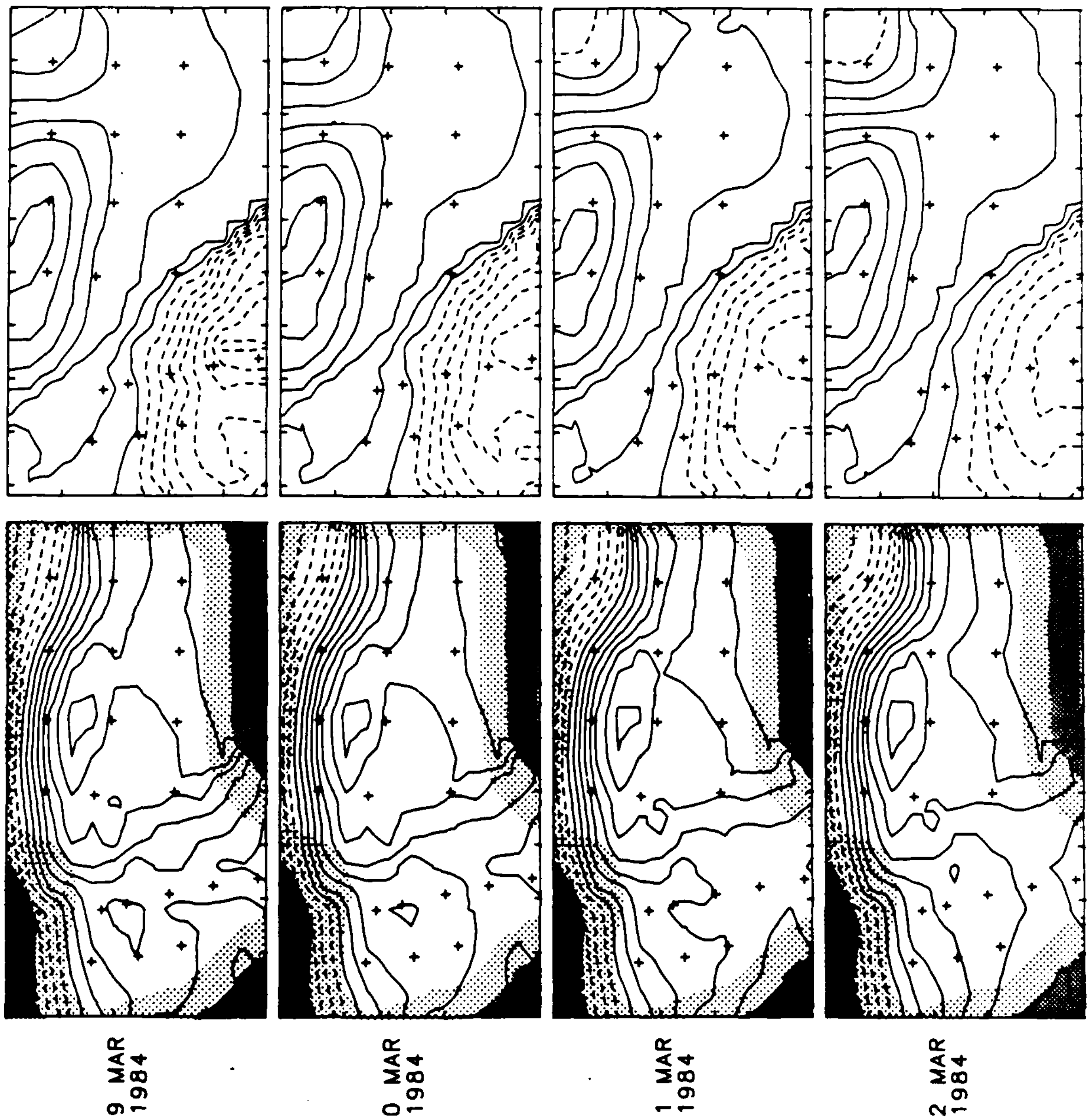
27 FEB 1984

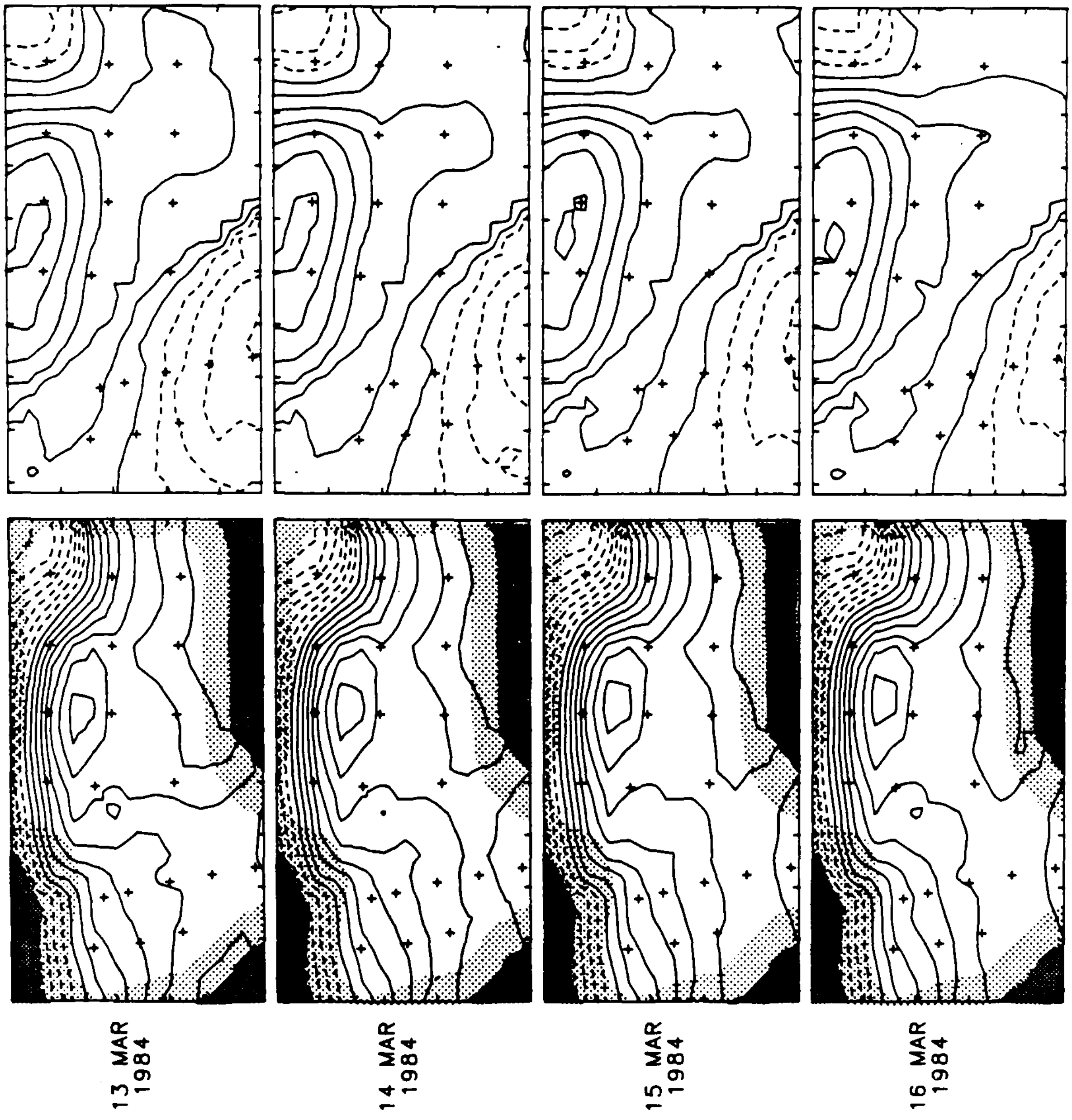
28 FEB 1984

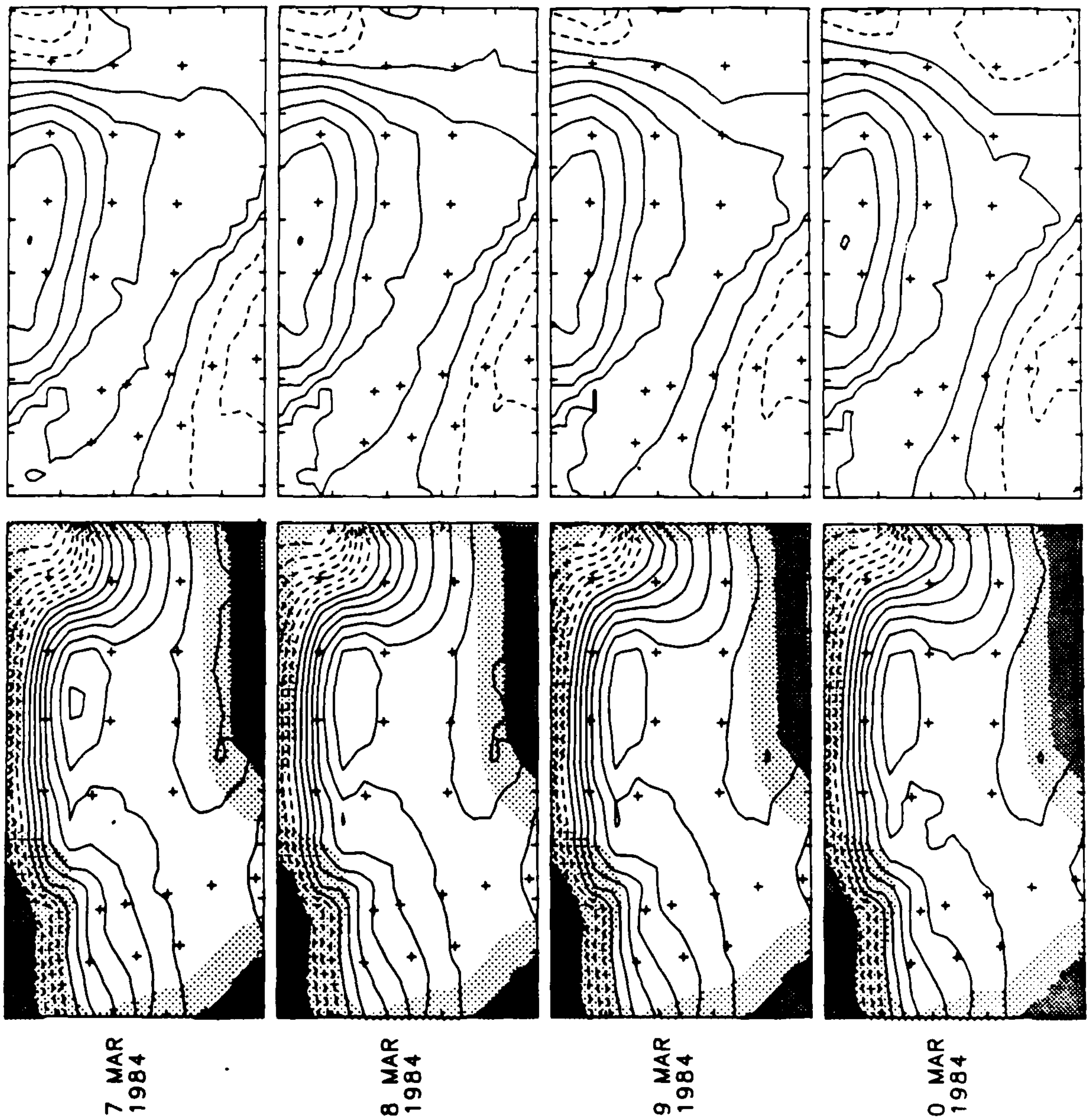
29 FEB 1984

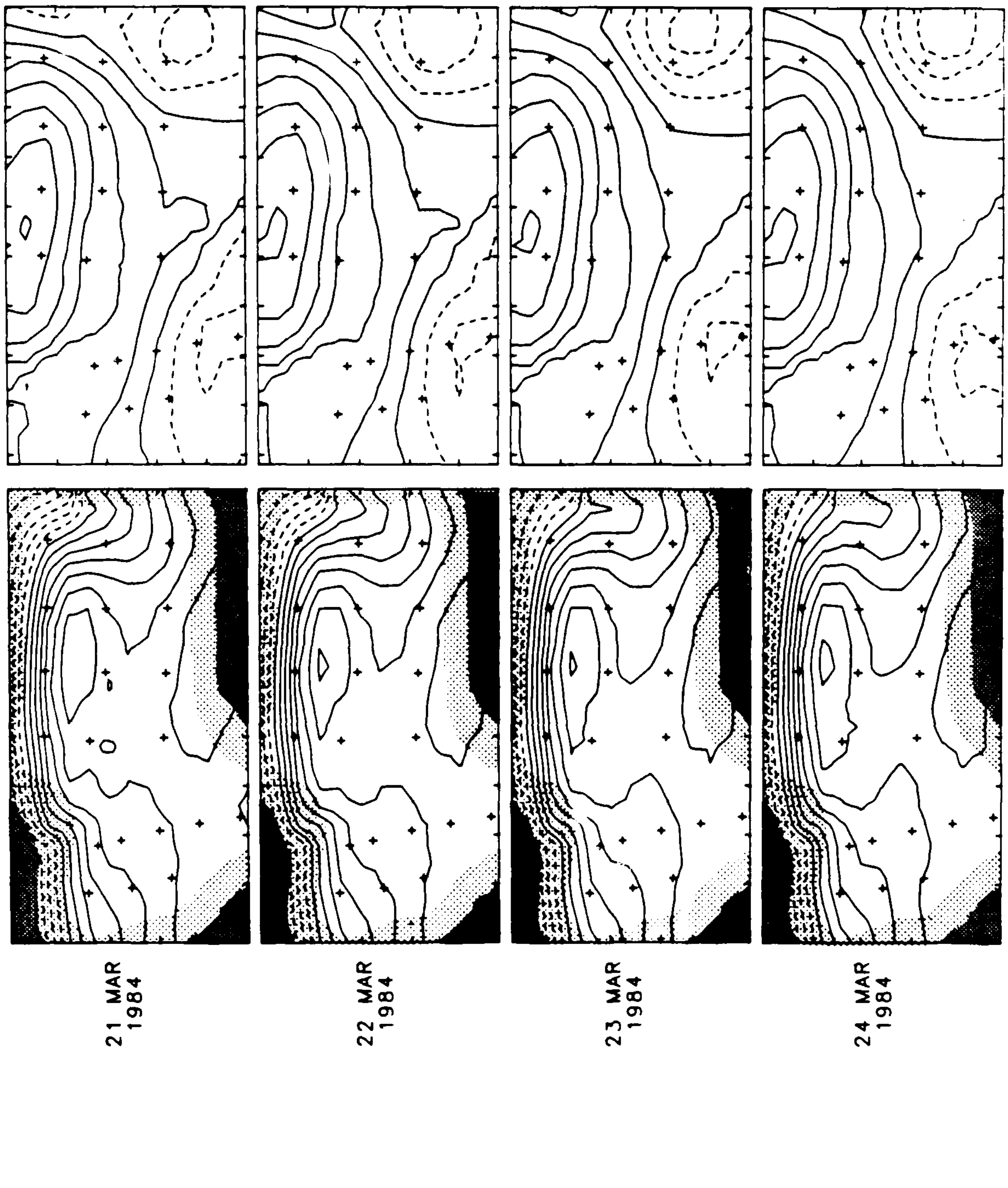

1 MAR 1984
2 MAR 1984
3 MAR 1984
4 MAR 1984


5 MAR 1984
6 MAR 1984
7 MAR 1984
8 MAR 1984


9 MAR 1984
10 MAR 1984
11 MAR 1984
12 MAR 1984


13 MAR 1984
14 MAR 1984
15 MAR 1984
16 MAR 1984


17 MAR 1984
18 MAR 1984
19 MAR 1984
20 MAR 1984

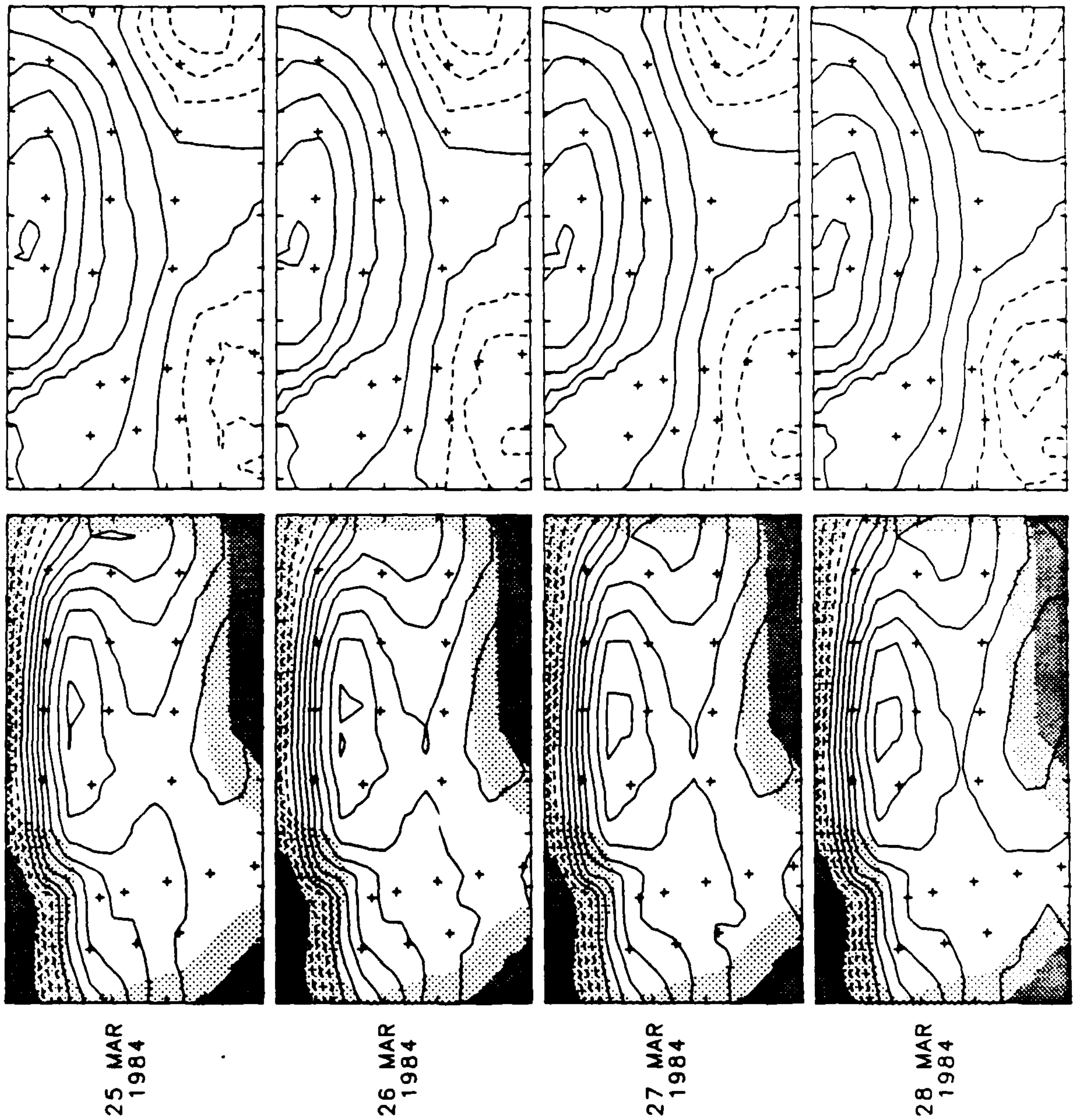


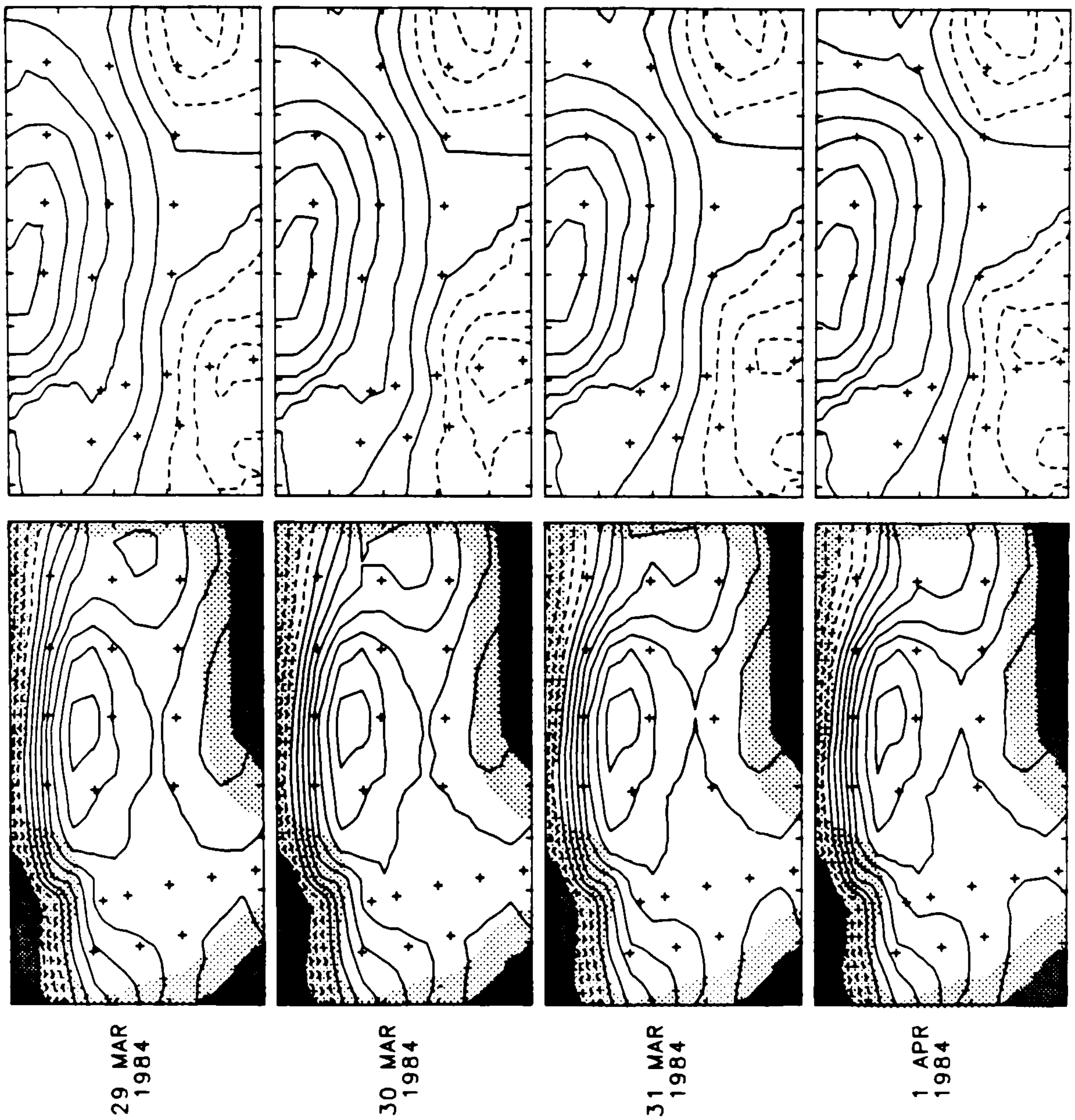
21 MAR 1984

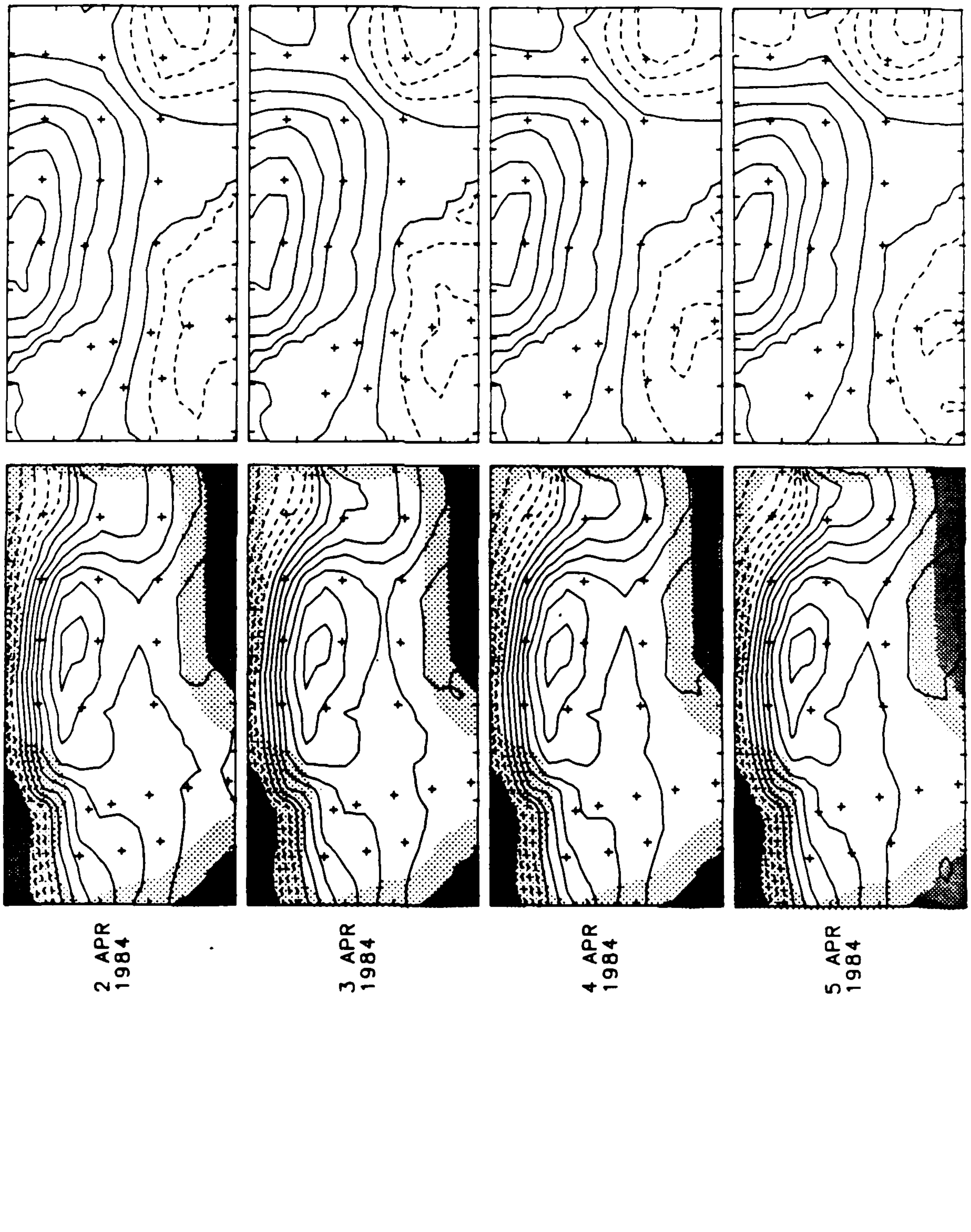
22 MAR 1984

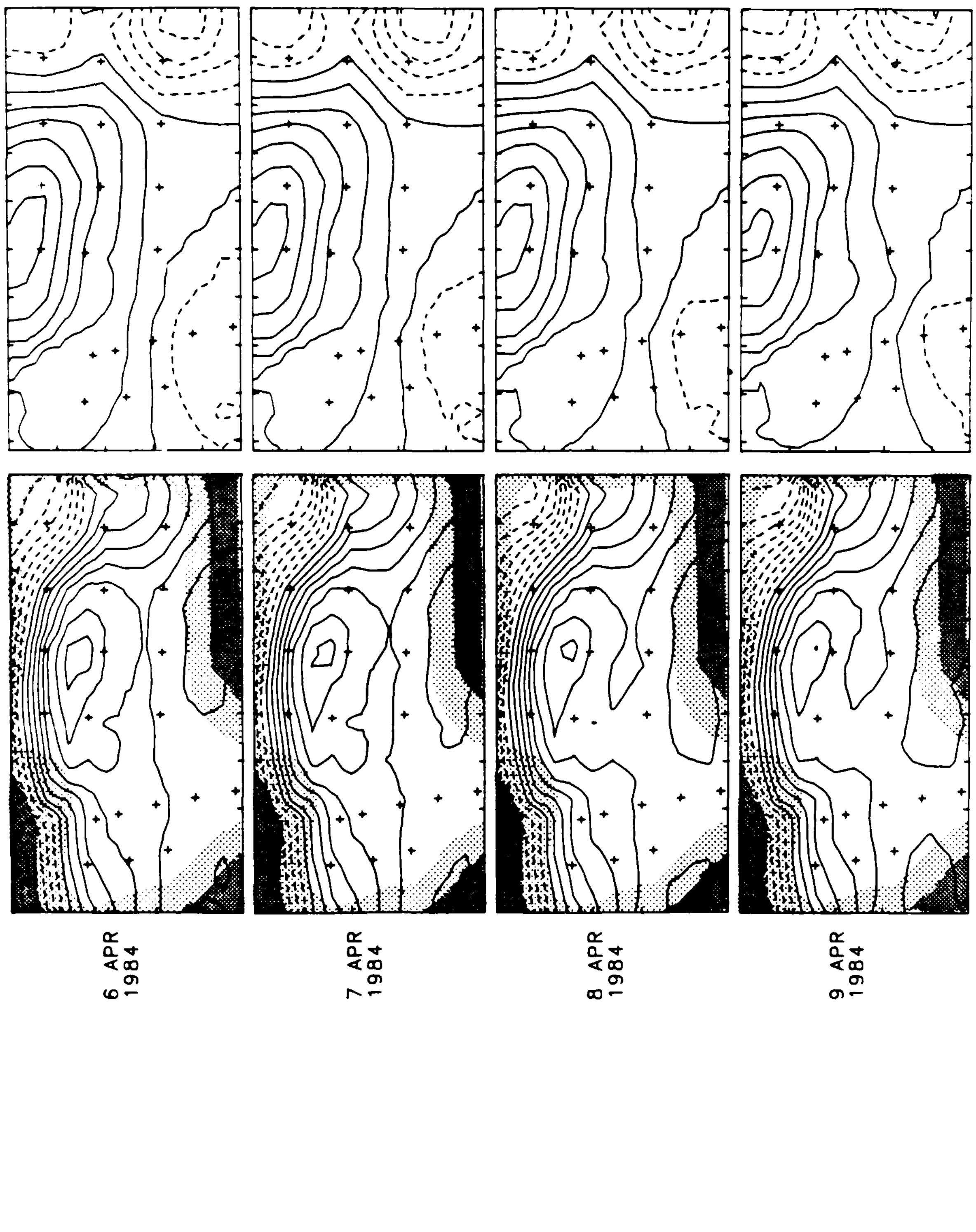
23 MAR 1984

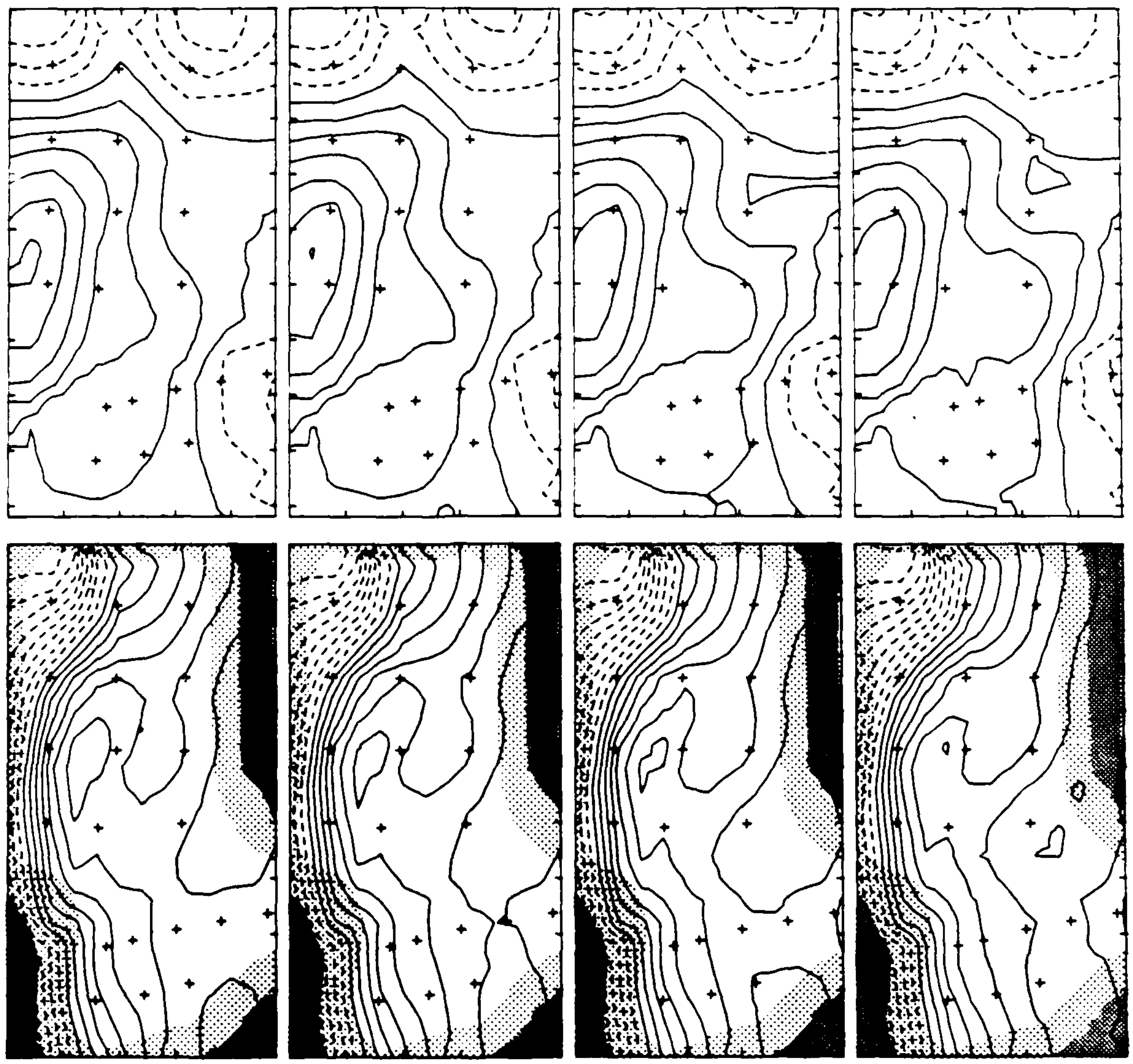
24 MAR 1984


25 MAR 1984
26 MAR 1984
27 MAR 1984
28 MAR 1984


29 MAR 1984
30 MAR 1984
31 MAR 1984
1 APR 1984


2 APR 1984
3 APR 1984
4 APR 1984
5 APR 1984


6 APR
1984
7 APR
1984
8 APR
1984
9 APR
1984

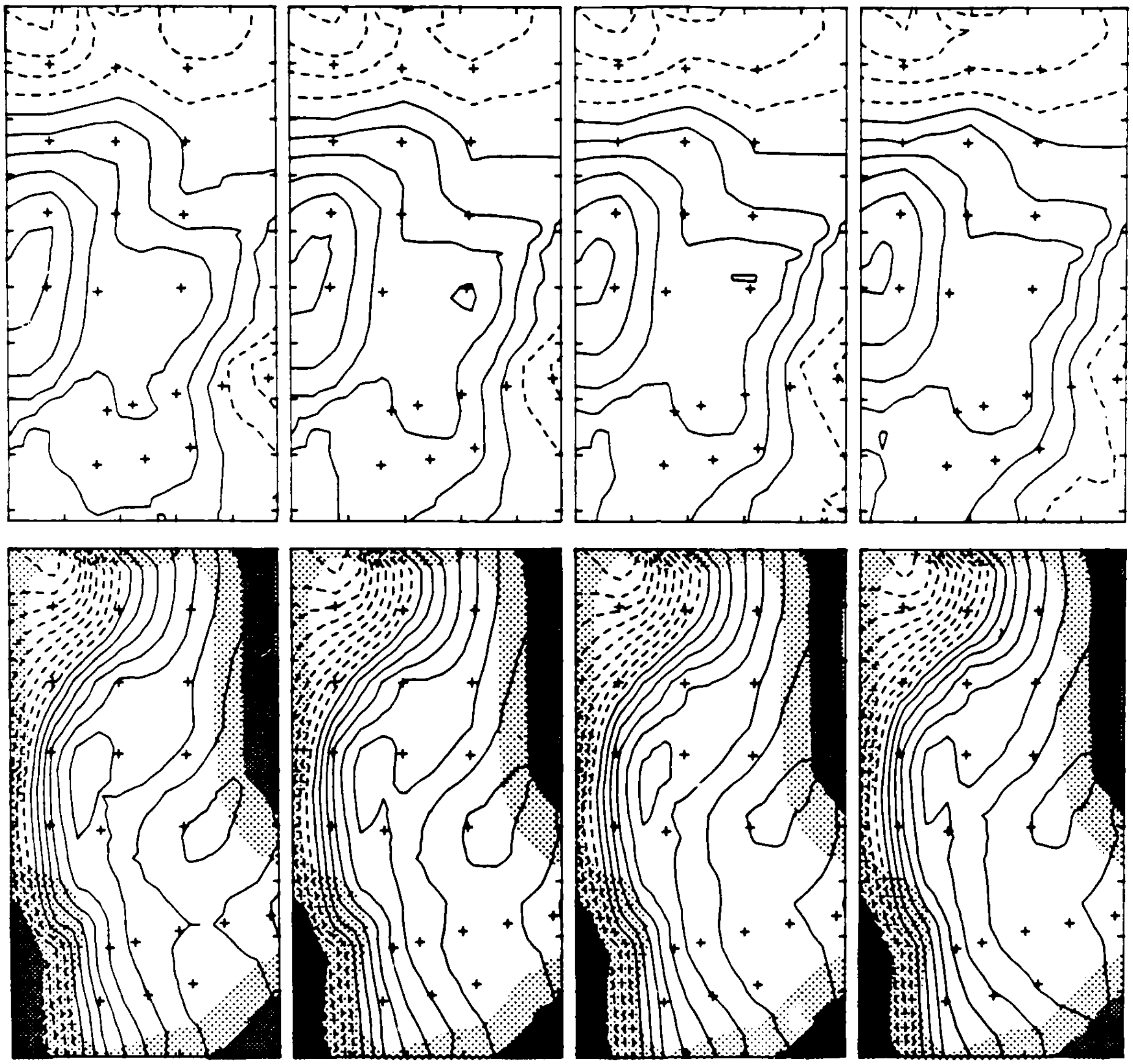


10 APR 1984

11 APR 1984

12 APR 1984

13 APR 1984

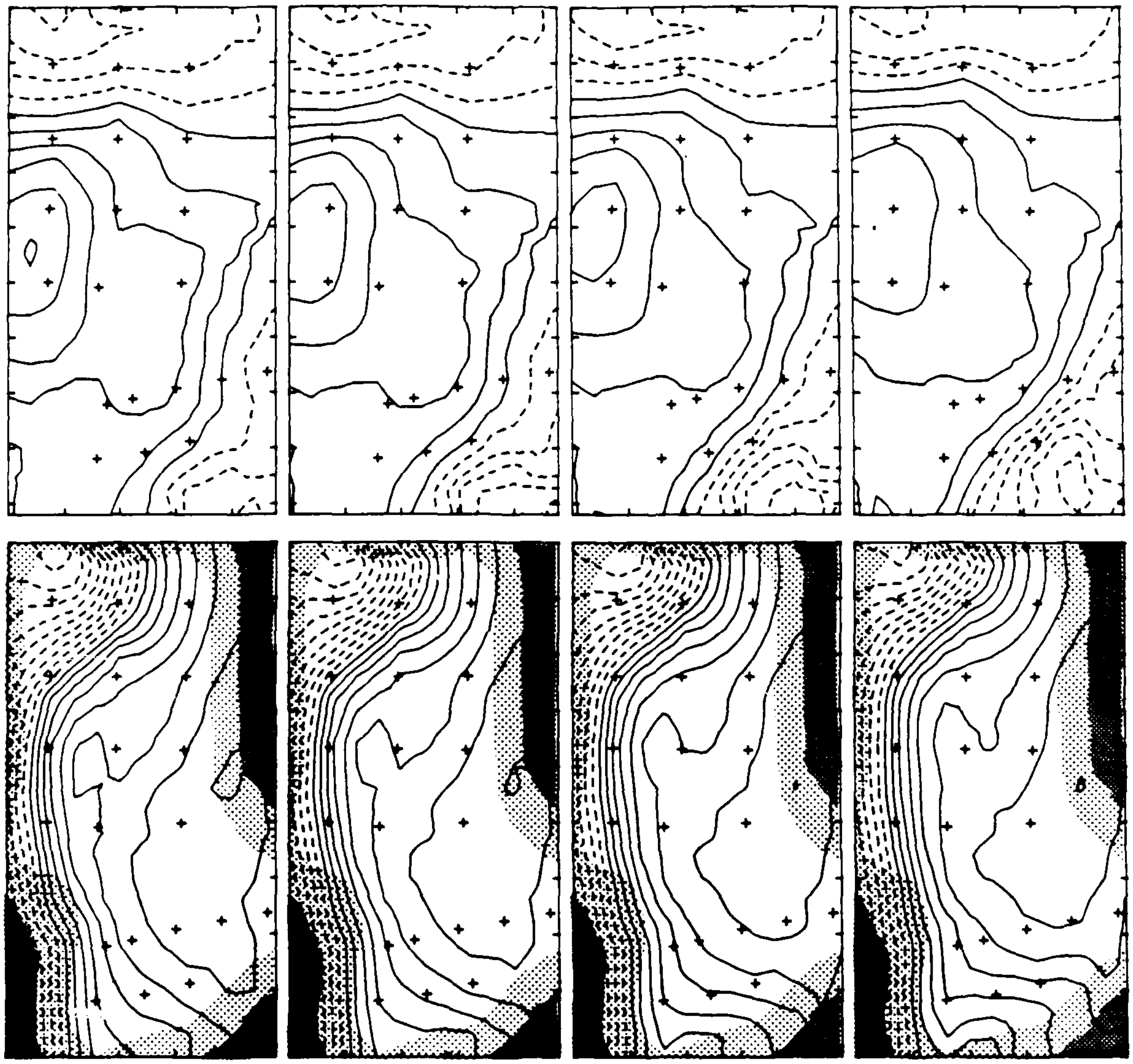


14 APR 1984

15 APR 1984

16 APR 1984

17 APR 1984

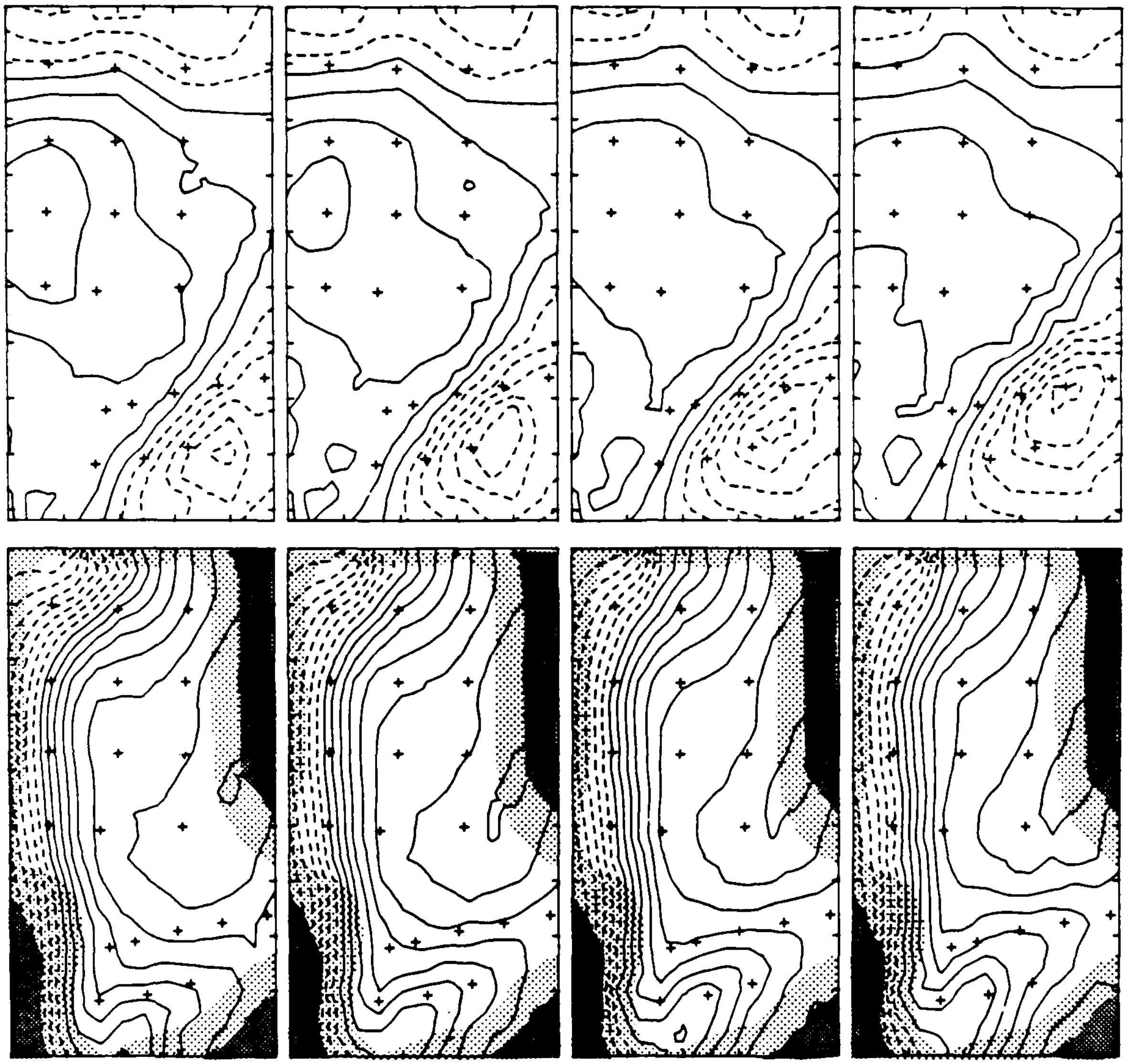


18 APR 1984

19 APR 1984

20 APR 1984

21 APR 1984

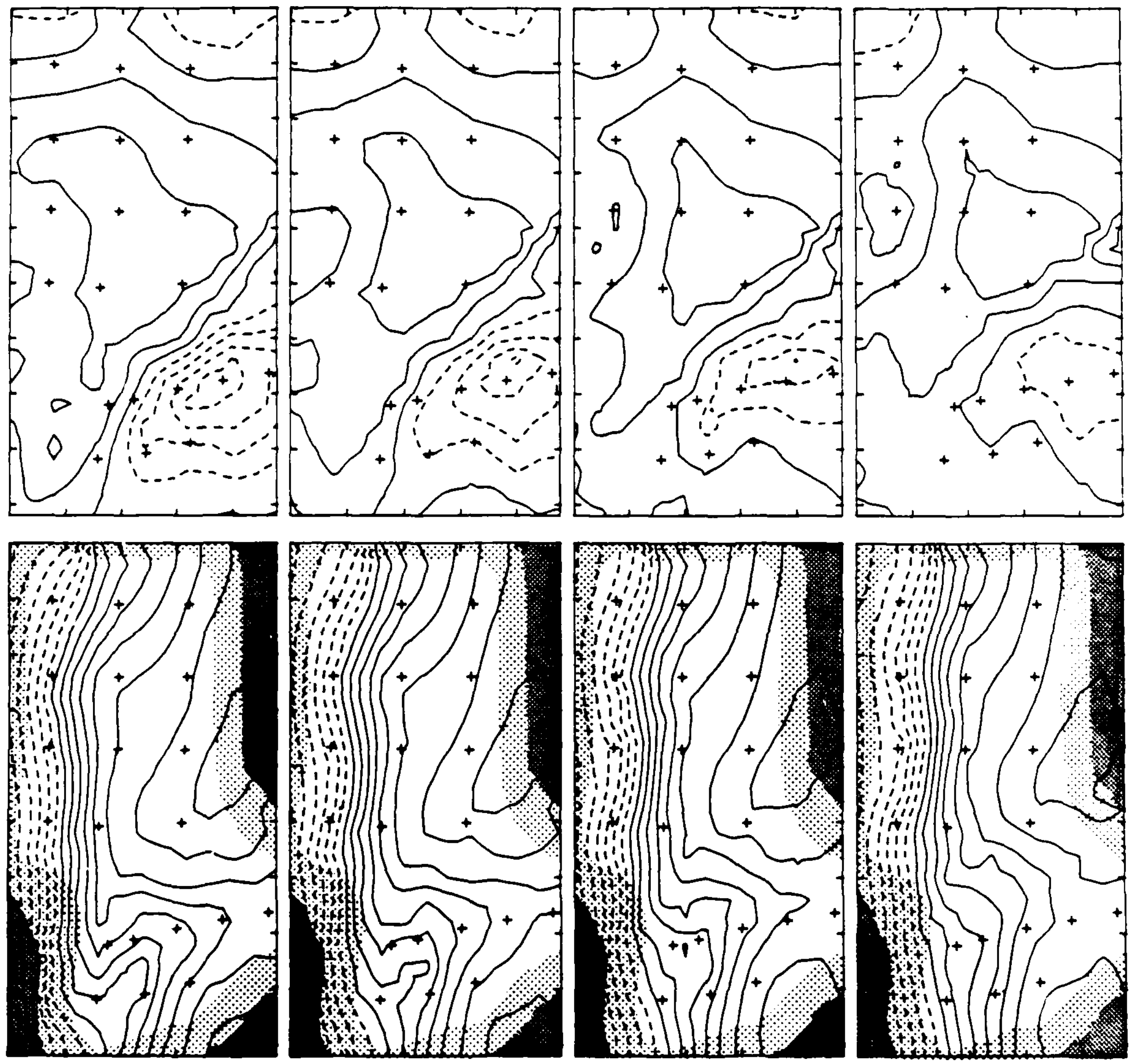


22 APR 1984

23 APR 1984

24 APR 1984

25 APR 1984

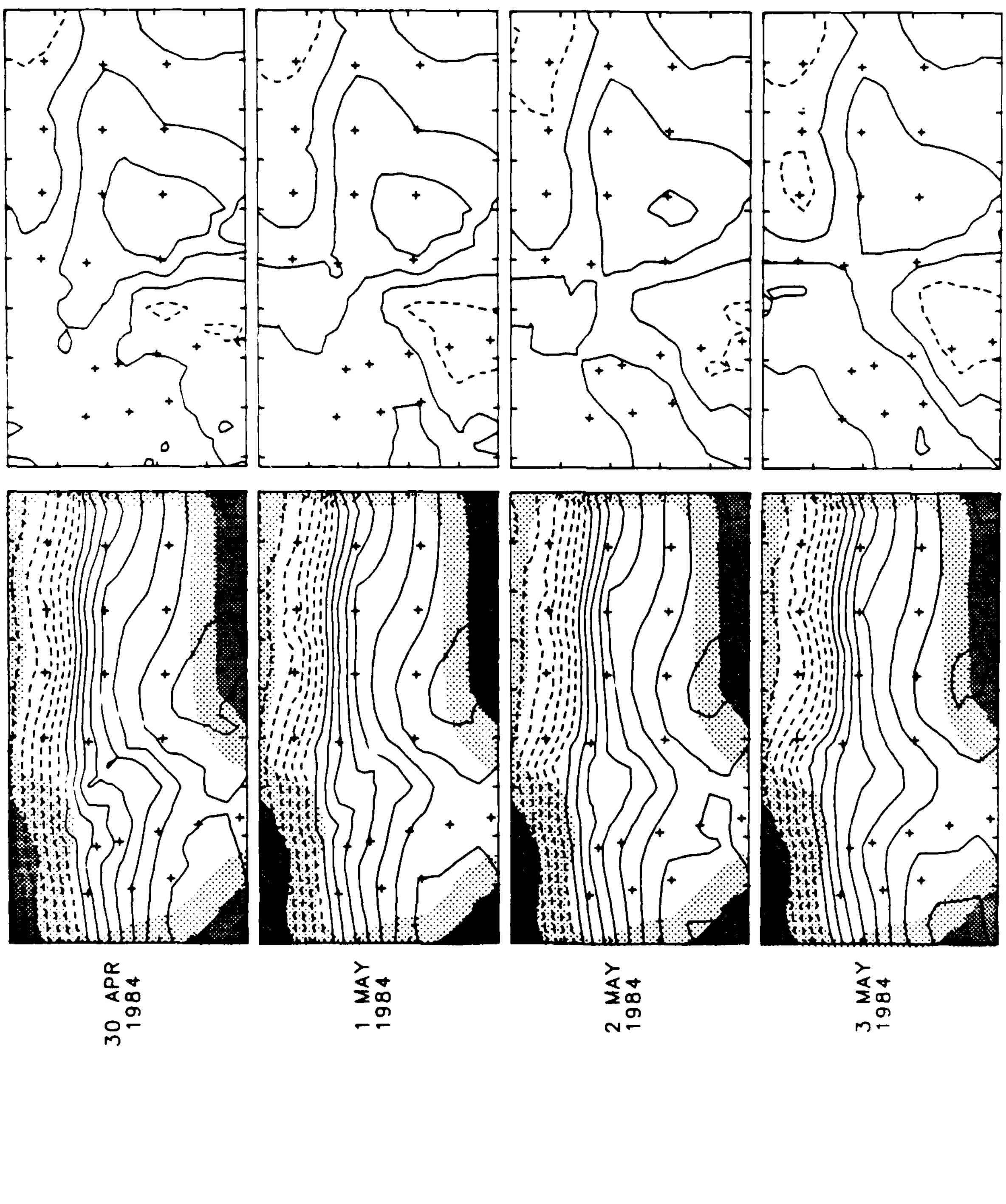


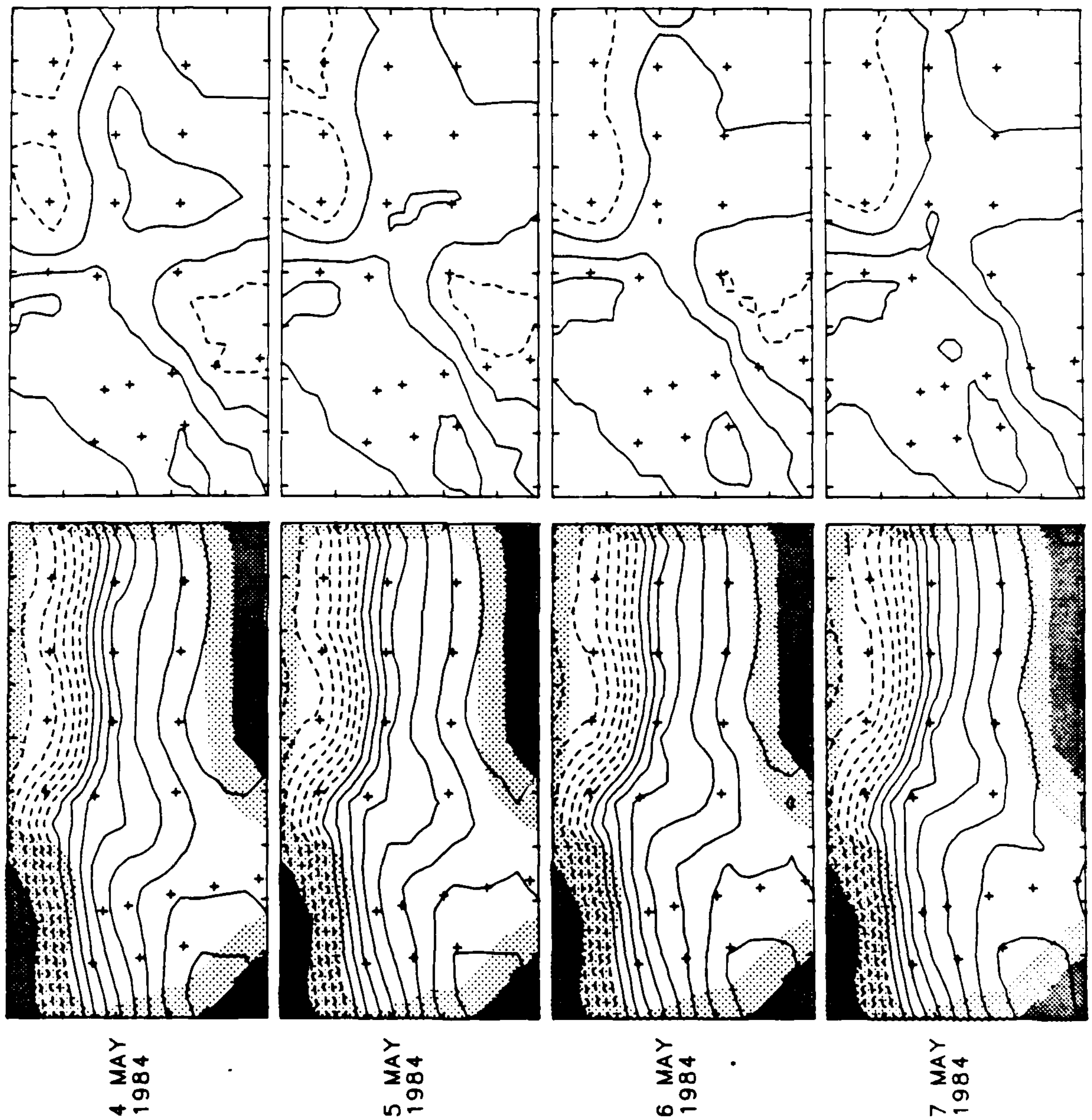
26 APR 1984

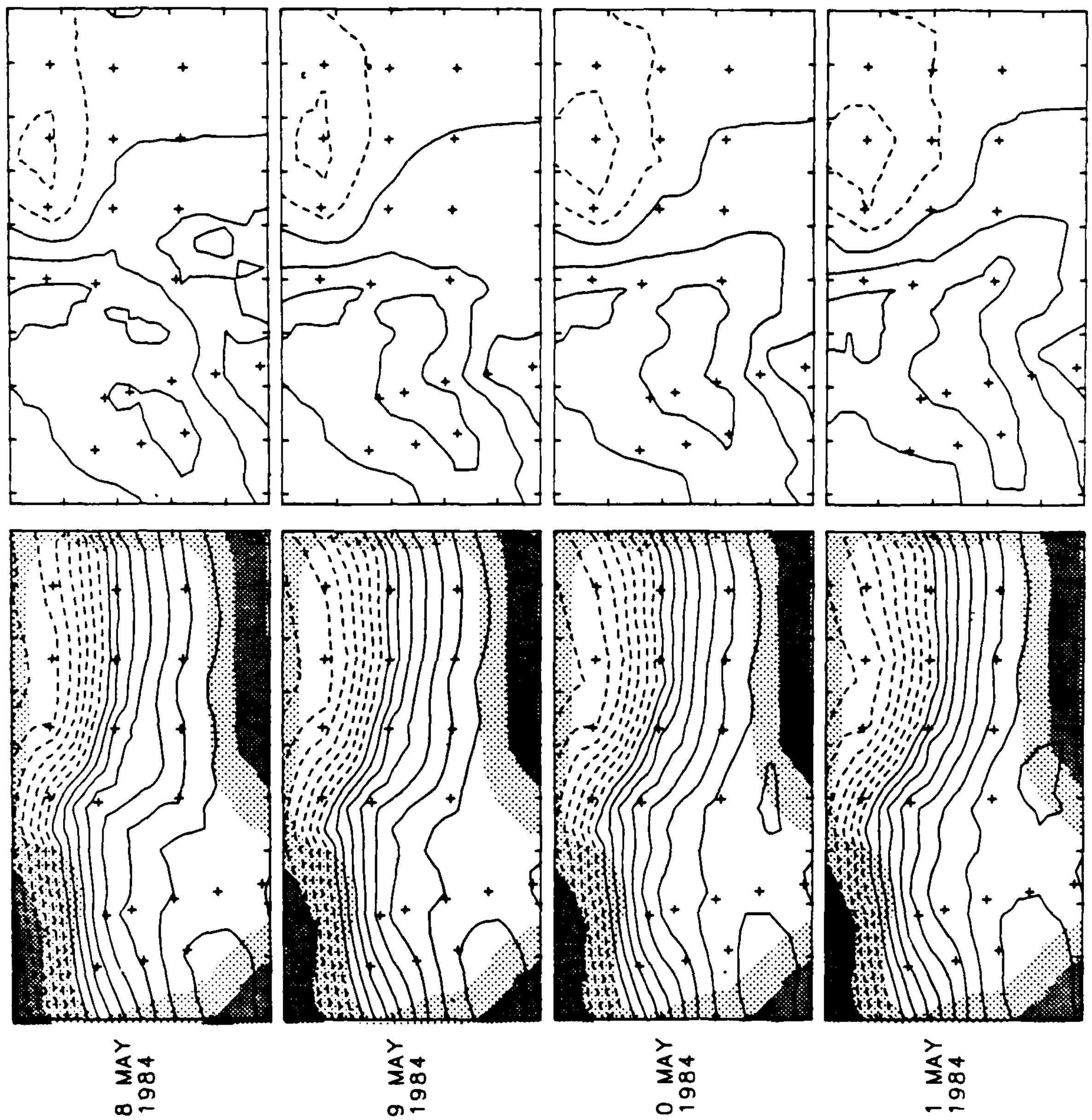
27 APR 1984

28 APR 1984

29 APR 1984


30 APR 1984
1 MAY 1984
2 MAY 1984
3 MAY 1984


4 MAY 1984
5 MAY 1984
6 MAY 1984
7 MAY 1984

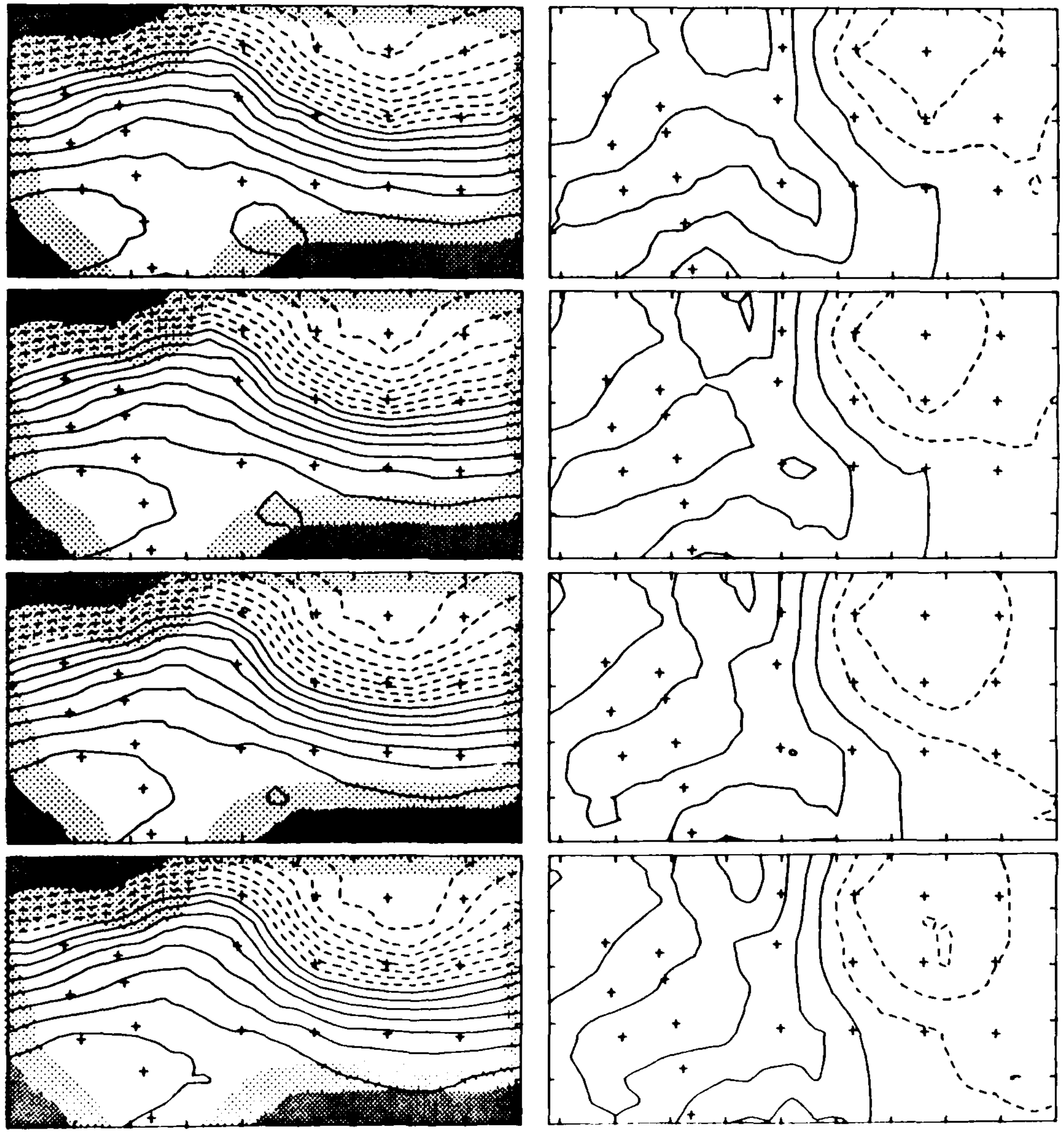

8 MAY 1984
9 MAY 1984
10 MAY 1984
11 MAY 1984

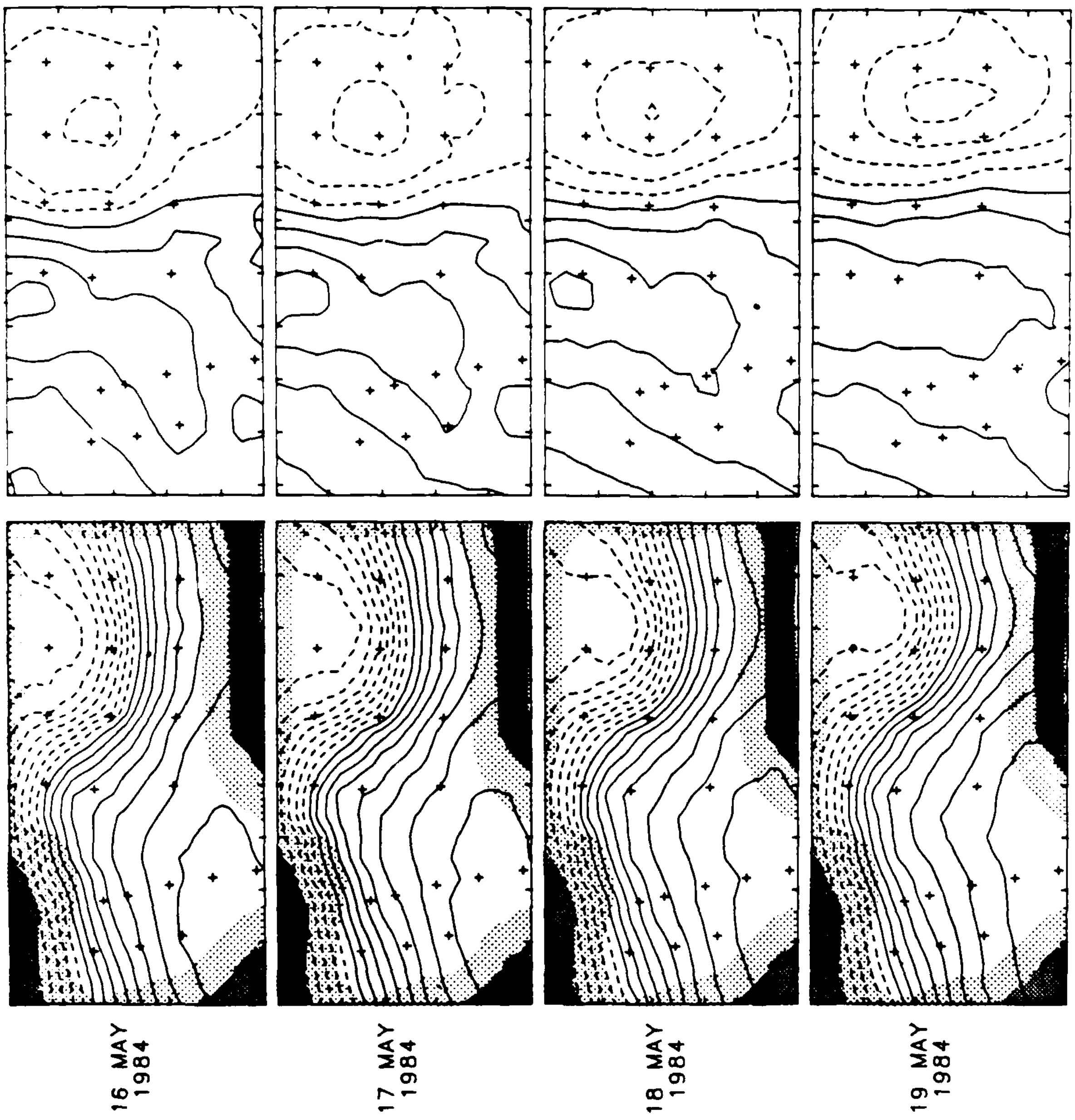
12 MAY 1984

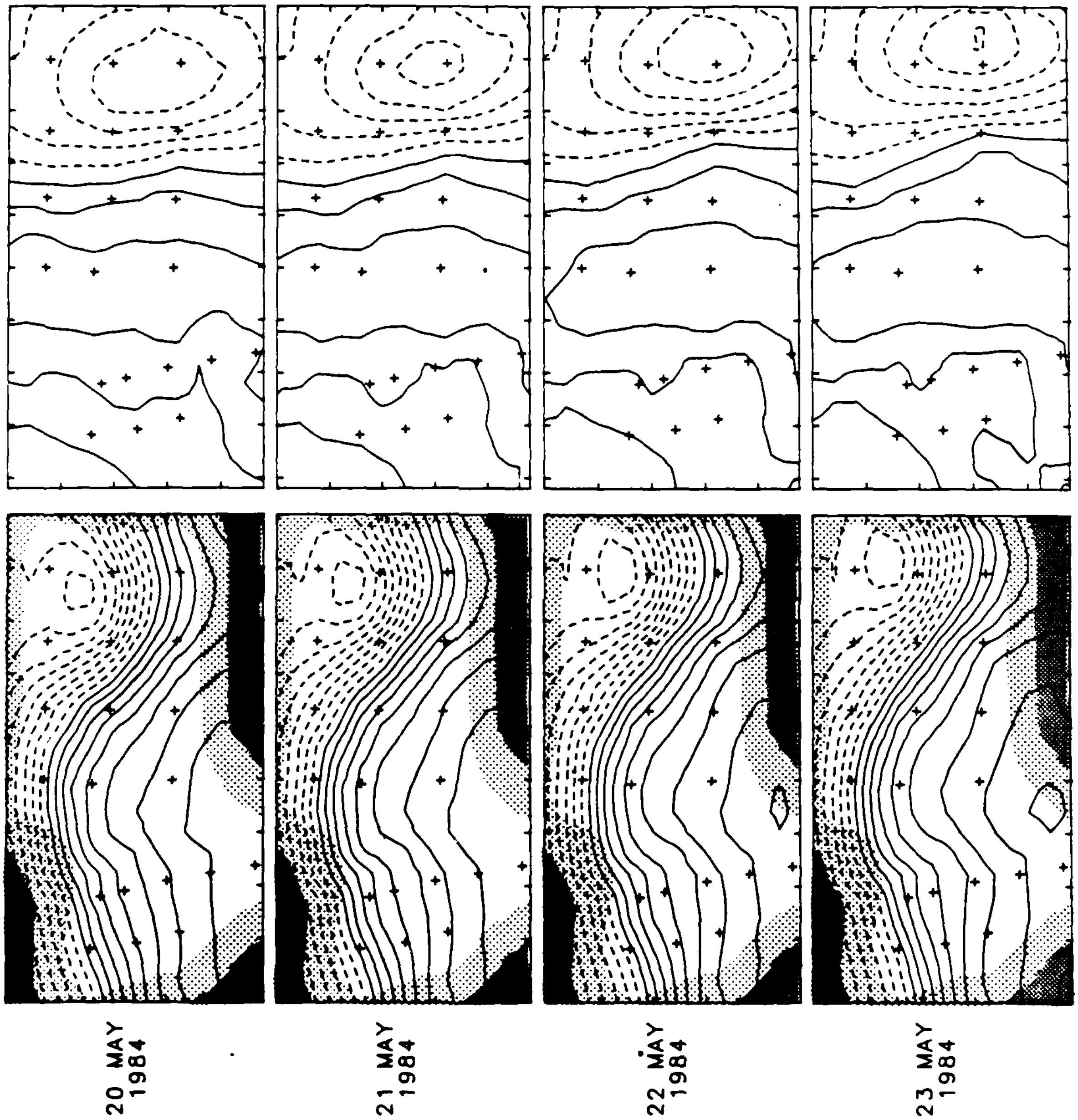
13 MAY 1984

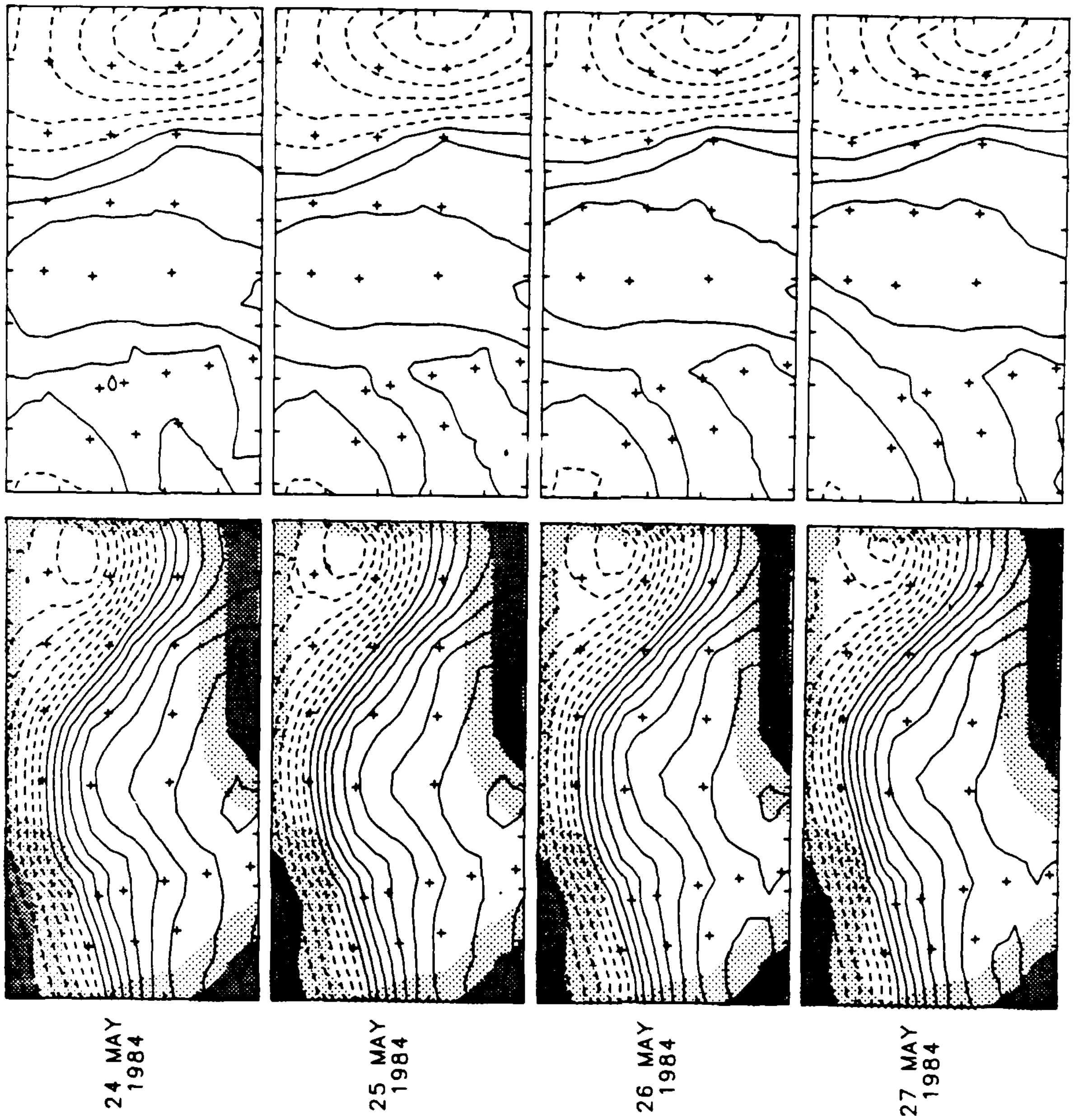
14 MAY 1984

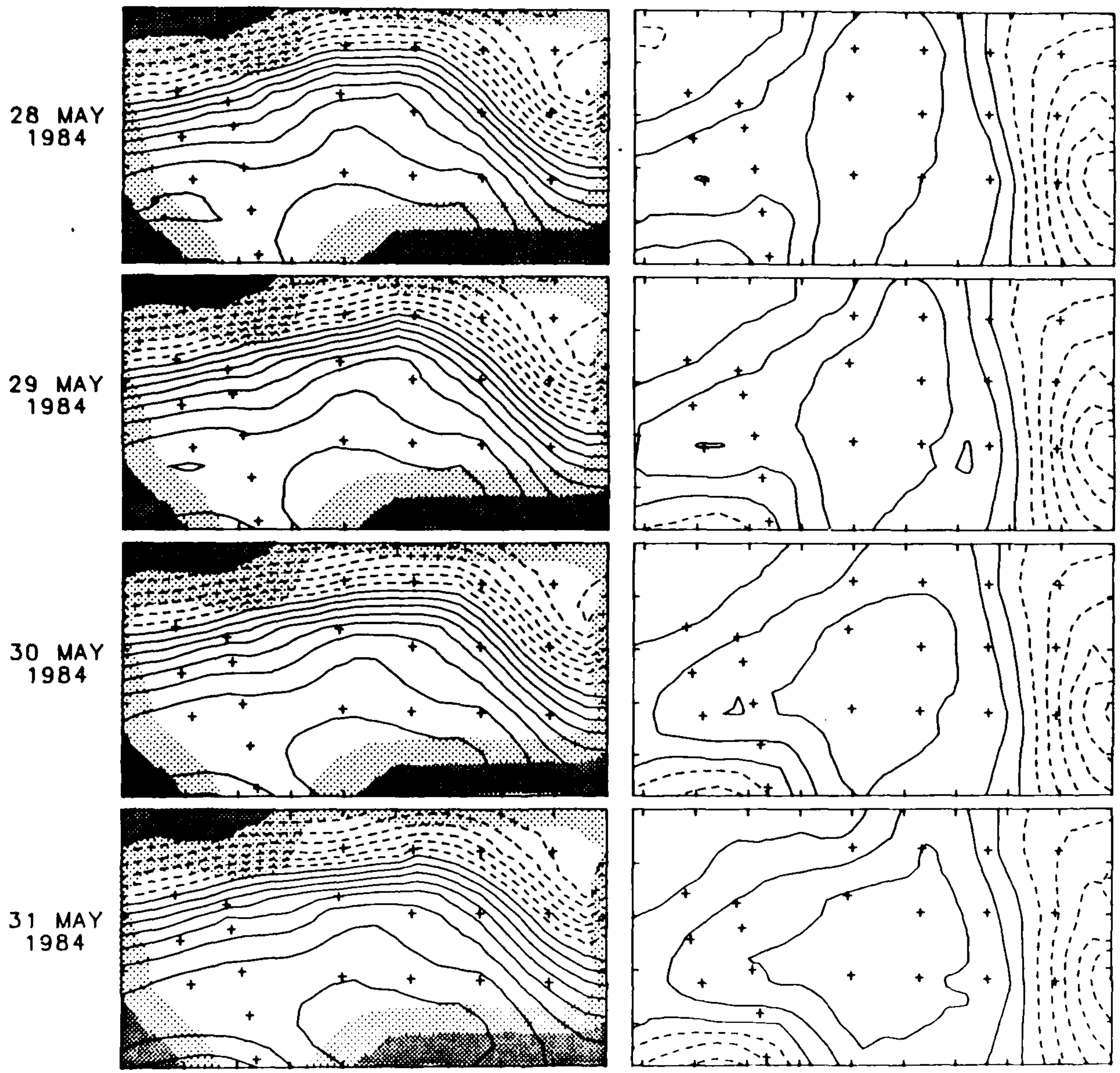
15 MAY 1984

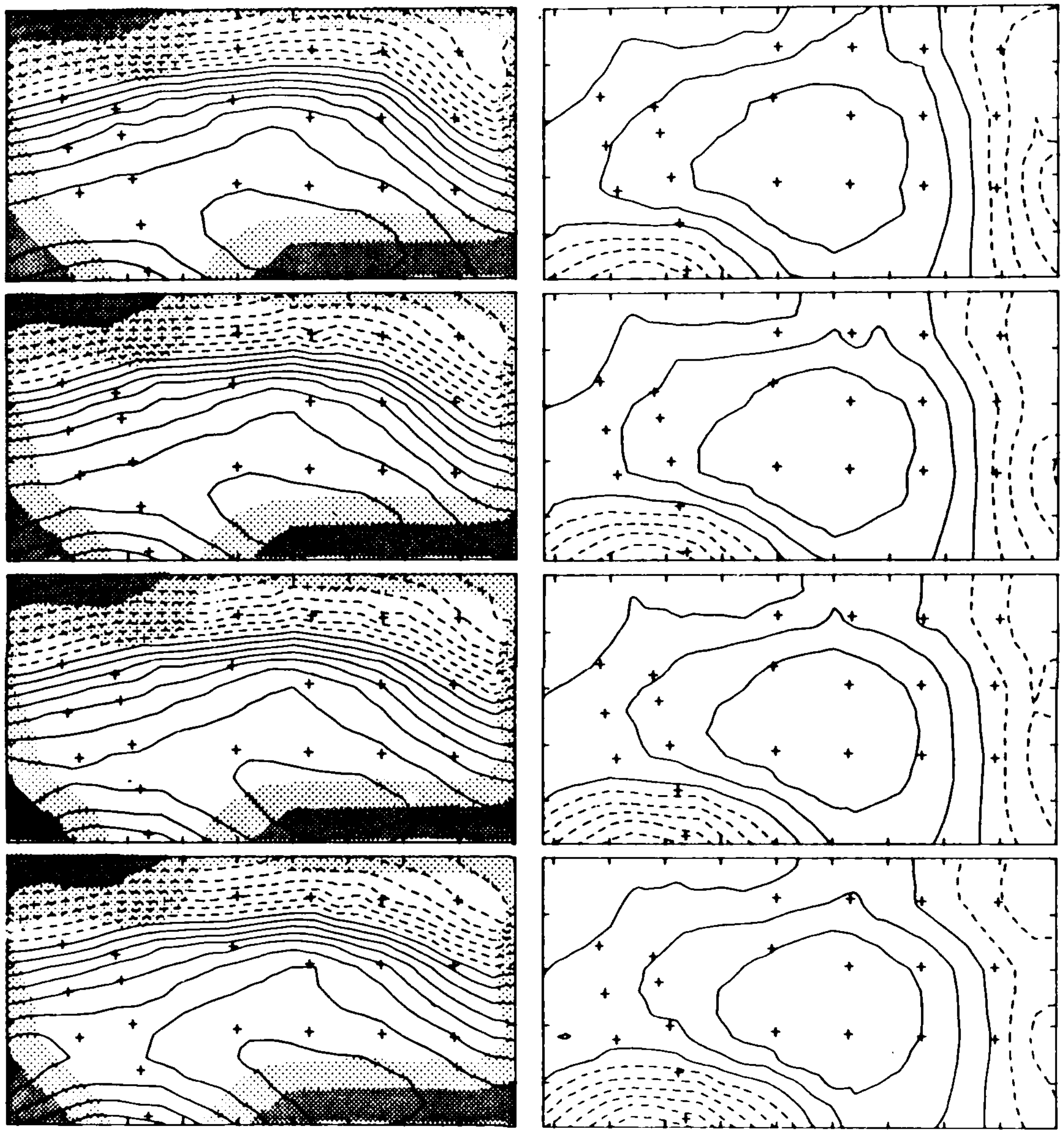


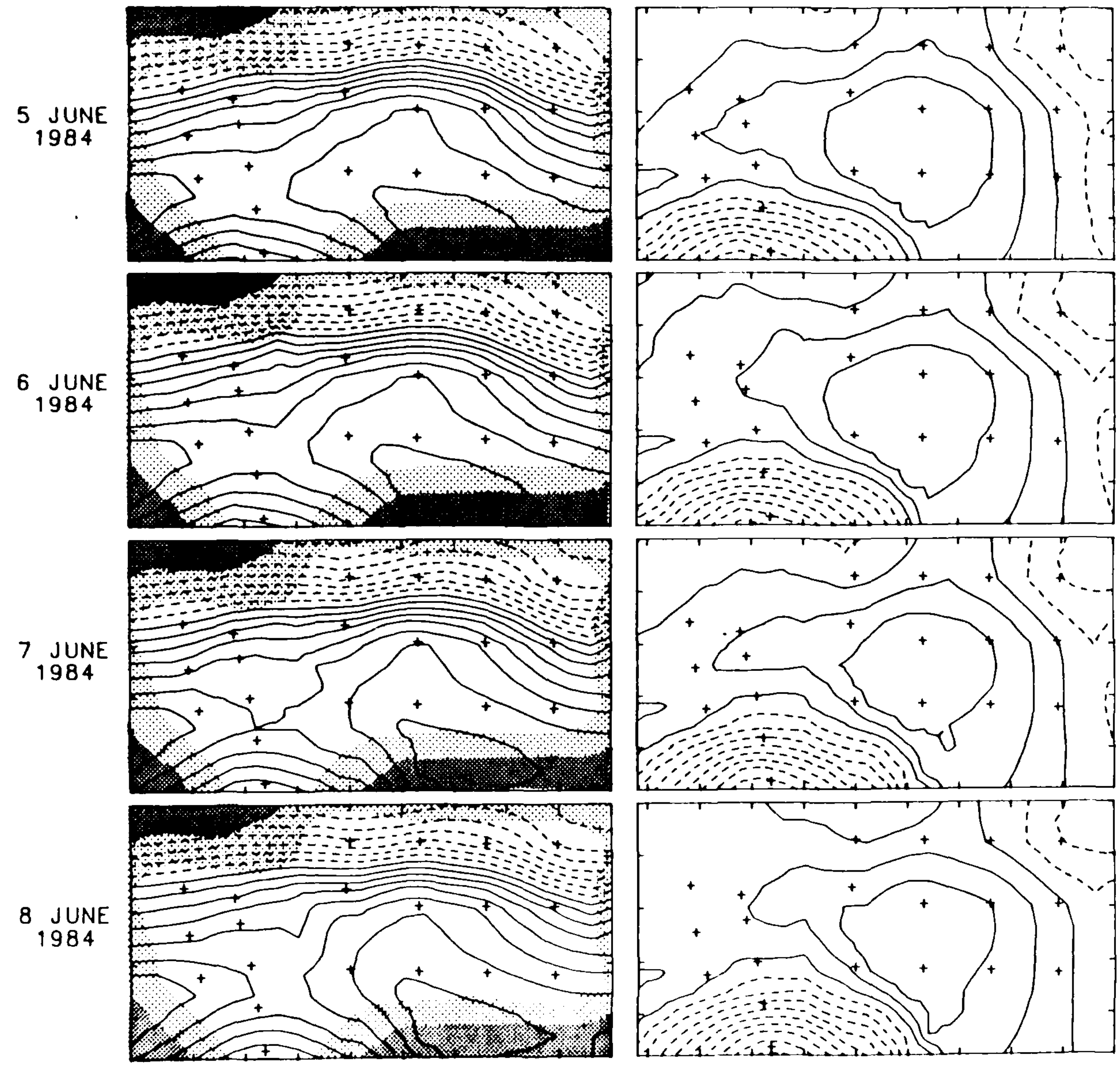

16 MAY 1984
17 MAY 1984
18 MAY 1984
19 MAY 1984

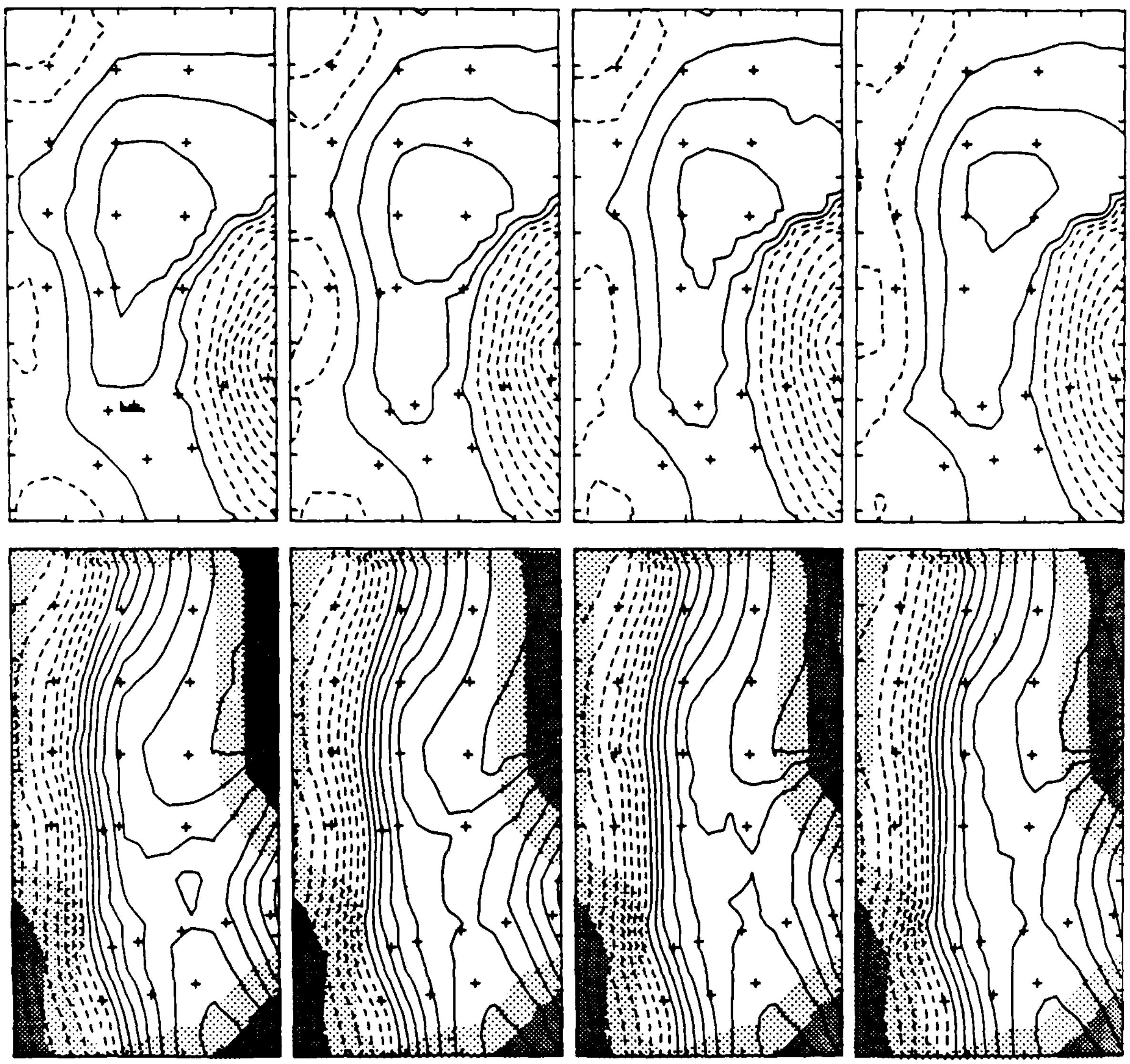

20 MAY 1984
21 MAY 1984
22 MAY 1984
23 MAY 1984


24 MAY 1984
25 MAY 1984
26 MAY 1984
27 MAY 1984


28 MAY 1984
29 MAY 1984
30 MAY 1984
31 MAY 1984


1 JUNE
1984
2 JUNE
1984
3 JUNE
1984
4 JUNE
1984


5 JUNE
1984
6 JUNE
1984
7 JUNE
1984
8 JUNE
1984

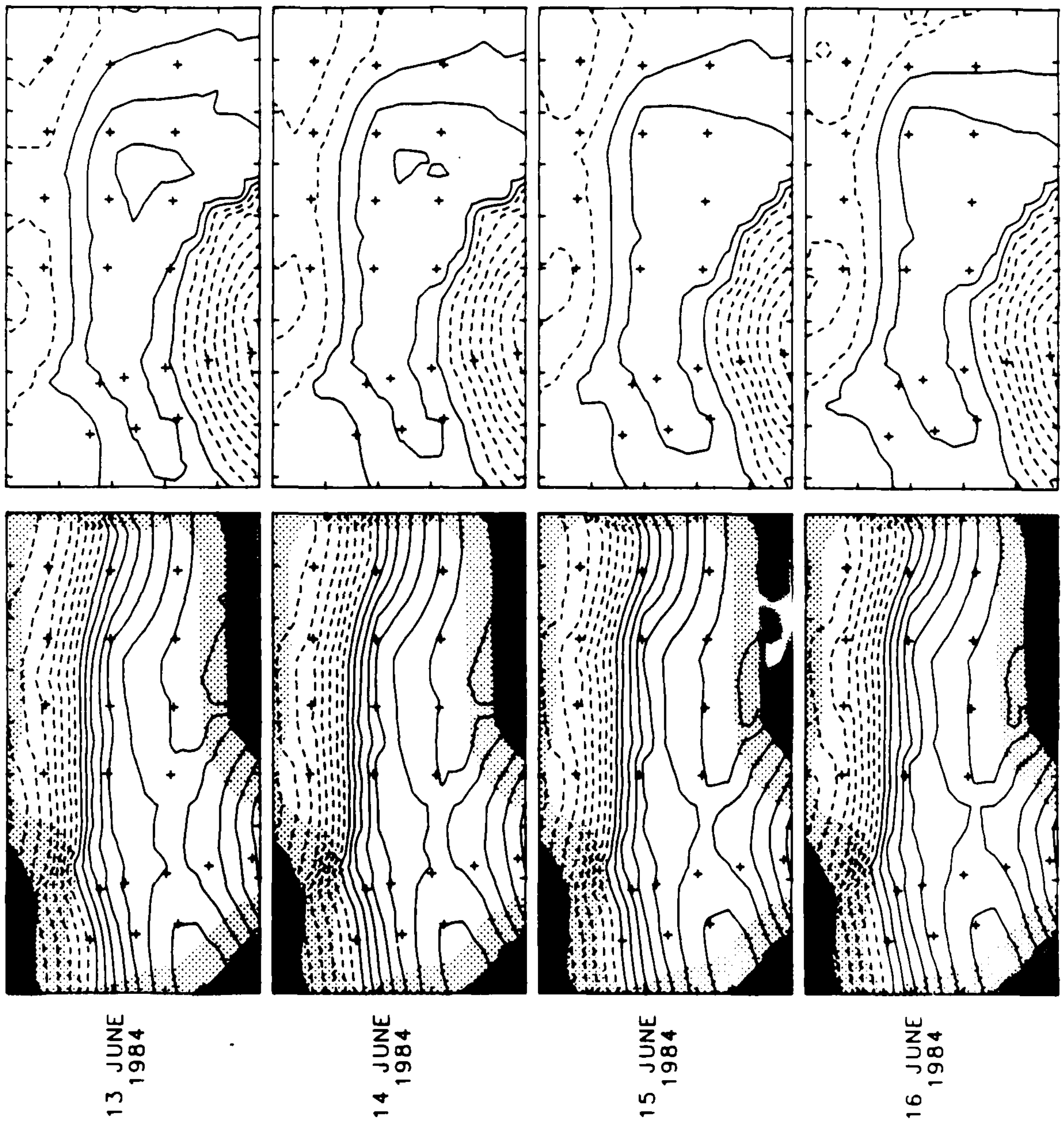


9 JUNE 1984

10 JUNE 1984

11 JUNE 1984

12 JUNE 1984


13 JUNE 1984
14 JUNE 1984
15 JUNE 1984
16 JUNE 1984

ACKNOWLEDGMENTS

The Gulf Stream Dynamics Experiment was supported by the National Science Foundation under grant number OCE-82-01222 and the Office of Naval Research under contract number N00014-81-C-0062. We thank the crews of the R/V ENDEAVOR, R/V OCEANUS, and R/V COLUMBUS ISELIN for their efforts during the deployment and recovery cruises. The successful deployment and recovery of the inverted echo sounders is due to the instrument development and careful preparation done by Gerard Chaplin and Michael Mulroney. It is a pleasure to acknowledge their efforts. Special thanks go to Harilaos Kontoyiannis who spent considerable time processing the pressure records and to Meghan Cronin who plotted the objective maps shown in this report. We thank Julie Rahn for careful editorial assistance. Skip Carter supplied the basic objective mapping and contouring programs. The FESTSA time series analysis package was modified for use on the PRIME 750 by David Lai, Eva Griffith, and Mark Wimbush.

REFERENCES

Brooks, D. A. 1976. (Editor). Fast and Easy Time Series Analysis at NCSU. Technical Report. Center for Marine and Coastal Studies. North Carolina State University. Raleigh, NC.

Carter, E. F. 1983. The statistics and dynamics of ocean eddies. Ph.D. Thesis. Harvard University.

Chaplin, G. and D. R. Watts. 1984. Inverted echo sounder development. Oceans '84 Conference Record. 1. 249-253.

Dixon, W. J. and M. B. Brown. 1979. (Editors). BMDP-79 Biomedical Computer Programs P-series. University of California Press. Berkeley, CA. 880 pp.

Munk, W. H. and D. E. Cartwright. 1966. Tidal spectroscopy and prediction. Philos. Trans. R. Soc. London. A 259. 533-581.

Rossby, T. 1969. On monitoring depth variations of the main thermocline acoustically. J. Geophys. Res. 74. 5542-5546.

Tracey, K. L. and D. R. Watts. 1986. Inverted echo sounder processing procedures. University of Rhode Island. GSO Technical Report (in preparation).

Tracey, K. L., M. Cronin and D. R. Watts. 1985. The Gulf Stream Dynamics Experiment: Inverted echo sounder data report for the June 1984 to May 1985 deployment period. University of Rhode Island. GSO Technical Report 85-3. 176 pp.

Watts, D. R. and W. E. Johns. 1982. Gulf Stream meanders: observations on propagation and growth. J. Geophys. Res. 87. 9467-9476.

Watts, D. R. and H. Kontoyiannis. 1986a. Deep-ocean bottom pressure records: Data report. University of Rhode Island. GSO Technical Report (in preparation).

Watts, D. R. and H. Kontoyiannis. 1986b. Deep-ocean bottom pressure records: Methods report. University of Rhode Island. GSO Technical Report (in preparation).

Watts, D. R. and H. T. Rossby. 1977. Measuring dynamic heights with inverted echo sounders: Results from MODE. J. Phys. Oceanogr. 7. 345-358.

Watts, D. R. and K. L. Tracey. 1985. Objective analysis of the Gulf Stream thermal front from inverted echo sounders. Gulf Stream Workshop Proceedings. University of Rhode Island. II. 525-548.

Watts, D. R. and K. L. Tracey. 1986. Objective analysis of the Gulf Stream thermal front: Methods report. University of Rhode Island. GSO Technical Report (in preparation).

Watts, D. R. and M. Wimbush. 1981. Sea surface height and thermocline depth variations measured from the sea floor. International Symposium on Acoustic Remote Sensing of the Atmosphere and Oceans, Proceedings, Calgary, Alberta, Canada.

Unclassifield

SECURITY CLASSIFICATION OF THIS PAGE AD-A170 734

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3. DISTRIBUTION / AVAILABILITY OF REPORT
Distribution for public release;
Distribution is unlimited.

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
University of Rhode Island
Graduate School of Oceanography
GSO Technical Report 86-4

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
University of Rhode Island
Graduate School of Oceanography

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code)
South Ferry Road
Narragansett, RI 02882

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING / SPONSORING ORGANIZATION
Office of Naval Research

8b. OFFICE SYMBOL (If applicable)
Code 422 P.O.

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
N00014-81-C-0062

8c. ADDRESS (City, State, and ZIP Code)
Code 422 P.O.
800 North Quincy
Arlington, VA 22217

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
The Gulf Stream Dynamics Experiment: Inverted Echo Sounder Data Report for the April 1983 to June 1984 Deployment Period (unclassified).

12. PERSONAL AUTHOR(S)
Karen L. Tracey and D. Randolph Watts

13a. TYPE OF REPORT
summary

13b. TIME COVERED
FROM 4/'83 TO 6/'84

14. DATE OF REPORT (Year, Month, Day)
86 April 30

15. PAGE COUNT
228

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Gulf Stream meanders
Inverted Echo Sounders

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from September 1983 to May 1985 to study the propagation and growth characteristics of Gulf Stream meanders. Data collected as part of the field experiment included inverted echo sounders, current meter moorings, and AXBT survey flights. This report documents the inverted echo sounder data collected from September 1983 to June 1984, as well as additional measurements made from April to September 1983. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for twenty-two instruments. Bottom pressure and temperature, measured at seven of the sites, are also plotted. Basic statistics are given for all the data records shown. Maps of the thermocline depth field in a 240 km by 460 km region are presented at daily intervals.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE (Include Area Code)

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

END

DTIC

9 — 86